An Investigation into Higher Education Users' Perception of Virtual Services at the University Campus Oldham

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Abstract:

Virtualization is a method of using computer technology in such a way that any one individual user is able to access many other devices remotely. In other words, it allows one computer to control many others or one operating system accessing multiple computers in order to analyse their databases. It can also be used in a way that there is no need for multiple servers, thus reducing the numbers needed by any one organisation. This will also allow the use of many different applications and software with less hardware. Applications are able to run faster and there will be increased availability with more users being able to use each piece of hardware as well as access to software licenses, which under normal circumstances can be expensive. The main attraction of virtualization is that access to a virtual desktop can be global as well as local by remote access with the ever expanding use of Broadband services, giving high speed internet access. There is also evidence to show that virtualization is growing in all areas, most importantly education, business and commerce.

Sharing many different services via the Cloud is increasing popular for both communication and data storage and that its capabilities may expand even further (Cafaro et al, 2010). As virtualization increases, surely that is the way education should evolve also. Therefore should the education system now be using virtualization to provide Knowledge as a Service? These are questions, which will be addressed by this thesis together with showing that virtualization would be more cost effective to run and be more flexible and faster; ensuring that both academic students and staff are working with up to date technology and resources. Finally by using theoretical models of program development for virtualization this thesis will demonstrate that introducing a virtual desktop would be accepted by users though there are some issues that would need addressing prior to any significant deployment in a higher education setting.

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Abbreviations

UCO	University Campus Oldham
BSC	British Computing Society
BSA	British Sociological Society
CAD	Computer Aided Design
CPU	Central Processing Unit
CSUQ	Computer System Usability Questionnaire
IBM	International Business Machines Corporation
ISO	International Organisation for Standardisation
IS	Information System
IT	Information Technology
LCC	Library & Computing Centre
PC	Personal Computer
PU	Perceived Use
PEU	Perceived Ease of Use
RAM	Random Access Memory
SAN	Storage Area Network
SCI	Sustainable, Construction and Innovation
SG	Soft Grid
SSL	Secure Socket Layer
SSPSS	Statistical Package for the Social Sciences

SVS	Storage Virtual Server
TAM	Technology Acceptance Model
TRA	Theory of Reasoned Action
UCO	University Campus Oldham
UK	United Kingdom
UTAUT	Unified Theory of Acceptance and Use of Technology
VPN	Virtual Private Network

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Chapter 1: Introduction

This thesis aims to look at whether the introduction of a virtual desktop at the University Campus Oldham (UCO) could be a future way of working and studying within a higher education establishment. UCO is a small higher education establishment offering academic courses affiliated to the University of Huddersfield. It houses an academic library together with computing facilities for both academic students and staff. The computing facilities are in constant demand and on occasion are not able to deliver its services to all its users all of the time. The method of study at present is via classroom and/or library environments together with study at home but without any remote access to the UCO's facilities. However, with today's advanced technology this method of studying could be the way forward. The increased demand on the facilities raises the question – could a virtual desktop be the solution for all users at the UCO? It may also benefit the UCO in a number of ways, not least the overseas students, who would not lose out during the term breaks, holidays, etc., as they could still access the university facilities remotely. Before identifying whether this would be a viable solution it is important to analyse whether users would accept such a solution. This is the purpose of this research study.

Chapter 1 will outline the conceptual and organisational framework together with a look at the aims and objectives of this thesis. Chapter 2 will consider academic literature surrounding virtualization and discuss the way it has been introduced within the education, business and commercial environments. Chapter 3 will look at the methodology used, with particular emphasis on the survey to be undertaken. Chapter 4 will show the results from the survey visually and analyse these, and finally Chapter 5 will draw conclusions from the research undertaken.

1.1 Conceptual Framework

The conceptual framework assists the researcher in the development of any research. The contents of this thesis will include reviewing literature surrounding desktop virtualization and models of program development, i.e. Technology Acceptance and Usability; together

with the Research Onion model (Saunders et al, 2008) as a method of explaining the research methodology. Prior to deploying any new technology it is important that studies are undertaken in order to determine whether the end users would accept the intended new technology and whether in fact it would be usable. Research questions will be outlined and discussed with the assistance of relevant journals, books, etc., which will also form part of this framework. The benefits of doing this are: clarity and focus to the project; it assists in re-enforcing what is already known about the subject; and helps to better communicate the ideas of the research. Both quantitative and qualitative research will be used, however it has to be noted that Miles and Huberman (1994) thought that qualitative research was not particularly required for the conceptual framework. Part of this framework also involves organisational learning, which looks at different analyses and concepts, in particular looking at attitudes, behaviours and cultures.

As this thesis involves obtaining and using information, it is also important to note that information should be used appropriately. ISO 17799 Standard (Appendix 1: ISO 17799 (Security policy)) is defined as:

> *"An asset that may exist in many forms and that has value to an organisation." (Janssen, R, 2010)*

Information as an asset is seen as any information that is documented and has value and that it should be protected at all costs. By following the ISO standard, all information will be secure by protecting:

> **Integrity** – means that the life cycle of any data remains consistent, accurate and trustworthy.
>
> **Availability** – means ensuring that all hardware/software is regularly maintained/upgraded and ready for use when required, so that there is no loss of information or any malicious actions, e.g. viruses.
>
> **Confidentiality** – means preventing any information being given to the wrong people, but ensuring that it does reach the correct ones. Some methods of achieving this is by data encryption; passwords, user IDs etc.

1.2 Organisational Framework

Education has undergone many changes over the years; long gone is the blackboard, now replaced by a smart board; Teaching is now being delivered across many sites/campuses/establishments, which means that new ways of teaching had to be introduced. Elton (1999), states that a new way of learning requires a new kind of institutional management. This would appear to be very different from the more traditional style, i.e. a facilitative role. As this facilitative role comprises of three levels, it appears that the first is apparently more acceptable:

"Creating conditions, through providing resources, recognition and rewards, for creative individuals and groups of staff to put their efforts into innovative teaching and learning, and developing favourable conditions for the continuing professional development of all staff"

This quote uses the words "*developing favourable conditions*", which could apply to new technology being made available to assist in the way learning is delivered.

There have been many studies on organisational change (Weick, 1985; Levitt & March, 1988; Senge, 1990; Huber, 1991; Weick and Westley, 1996; Crossan et al, 1999; Pokhareland Hult, 2010), all of which discuss organisational development, change and learning; the concept of gaining knowledge, interpreting data and sharing all information for continuous improvement. This meant that educational establishments also had to look at different ways of delivering knowledge to students.

The studies show that change is an ongoing process and that all services need to improve in order to be more efficient and effective. The Department of Business, Innovation and Skills published a White Paper – "*Supporting Analysis for the Higher Education*" in 2011, which stated that there was more competition between Higher Education establishments than ever. They had to look at ways to maintain their student intake, as some establishments may not be able to remain viable in the future. Therefore the UCO would need to look at ways to retain and recruit students. One way would be to improve the services of the Library and Computing Centre (LCC). This would mean that the LCC has to change with the times to achieve quality in order to improve the service it provides including making innovative changes. This re-enforces Ian Smith's (2011) way of

thinking that libraries have a proven track record indicating that they are open to organisational change and innovative ways of management. The service currently provided to staff and students are all library and computing facilities, which involve the use of many software programs that can be expensive to buy (Appendix 9: Licence costs). This enables both staff and students to use all programs without worrying about whether they would have to buy them for themselves.

1.3 Dissertation Aim

The aim of this dissertation is to determine whether the academic staff and students' perception of virtual desktops and their potential use could be a more effective way of working and studying.

1.4 Dissertation Objectives

It is intended to determine the following objectives:

To identify whether the Virtual Desktop could be accepted by both staff and students

This will be determined by using a feedback survey using Technology Acceptance and Usability models.

To determine how a virtual desktop would benefit both staff and students

This will identify whether the advantages outweigh the disadvantages on the use of a virtual desktop by staff and students at UCO.

The research questions that will be asked are:

- *Could a virtual desktop be accepted by both staff and students at UCO?*
- *Could the concepts of usability enhance the value of a virtual desktop?*
- *Would a virtual desktop be advantageous to all users at the UCO?*
- *Could virtualization be the future method of studying for higher education establishments such as the UCO?*

1.5 Different Models of Virtualization

1.5.1 Introduction to Virtualization

The first recorded network communication was in 1940, when an American professor by the name of George Stibitz, sent information from New Hampshire to a computer in New York and received a reply the same way (Grier, 2006). Although this was of great importance, it still required the user to manually intercede. What was needed was for computers to exchange data autonomously with the use of both hardware and software (Liu, J, Ansari, N, 2004). Since 1940 computers and networks have evolved in such a way that communication is faster and storage of information is very different. It was initially costly to set up and maintain data centres; therefore large organisations used to rent the use of computer power together with data storage from large data centres, e.g. IBM, who had developed large mainframe computers (Cafaro, M, Aloisio, G, 2011). It then took approximately forty years (early 1980s) before organisations started to acquire personal computers and workstations, which meant that data was acquired and stored more swiftly than when having to rely on large external data centres. At the present time data storage is much cheaper and network speeds are that much faster, thus enabling economies of scale and virtual services.

In 1965 Gordon Moore predicted that transistors on a silicon chip would increase two fold every year, which he later altered to every two years (Ulaby. F, T, 2006). Ultimately the legacy of "Moore's Law" is that technology is built on the achievements of others rather than it being discarded. An example of this are the changes made to the Apple computer over a ten year period. Figure 1 shows that both the visual changes as well as the specifications are very striking.

Approximately twenty years later, in the 1960s, the concept of virtualization was introduced again by IBM. This enabled interactive access to their mainframe computers by organisations, who could now access the physical machine albeit virtually. This allowed organisations to save on hardware costs and improve productivity as more users were able to access the system at the same time. Unfortunately the following years saw hardware becoming much cheaper multiprocessing systems started to appear. This caused virtualization to diminish and almost disappear but the 1990s saw a re-emergence of

virtualization due to the appearance of more varied operating systems together with PC based hardware. Even though virtualization has potentially very significant benefits for IT provision, defining virtualization was at times difficult to find. Two definitions of virtualization found during this research were:

> *"…a computer within a computer, implemented in software" (Campbell, S, Jeronimo, M, 2006).*

> *"…virtualization refers to the various techniques methods or approaches of creating a virtual version of something such as a virtual hardware platform operating system storage device or network resources" (www.definitions.net).*

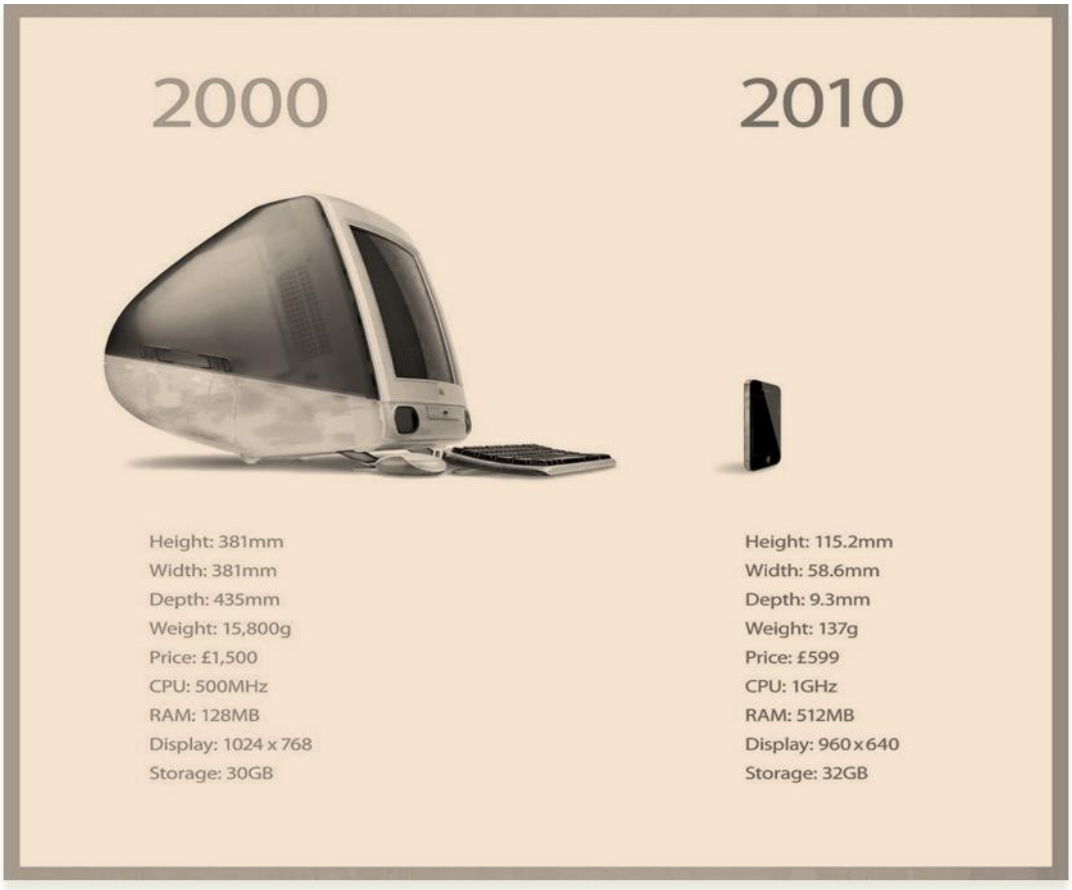


Figure 1: Moore's Law and Apple (www.tuaw.com . 2010)

Having defined the concept of virtualization, the different models of virtualization will determine the type of virtualization to use for this research.

1.5.2 Operating System Virtualization

Multiple operating systems can be run at the same time on one piece of hardware with the use of special software, e.g. Citrix; Leostream; Propero; and Provision Networks. This allows organisations to benefit by reducing costs as they ultimately require less hardware and power.

1.5.3 Network Virtualization

This method combines all available resources within a network and dividing the available communication capacity into routes. These routes can then be allocated to any one device or server in real time (Pawar, U, Bhelotkar, M, 2011). In other words it allows for many virtual networks to be created on the same server. This network would then support Virtual Local Area Networks; Virtual Service Networks and Virtual Private Networks. It is an open model, which can be expanded as required as well as offering the service of all sizes can fit into one (Rouskas, G, N, 2012).

1.5.4 Storage Virtualization

Storage Area Networks (SANs) are commonly used for storage virtualisation. These networks are usually linked via a high speed link to servers. This permits storage performance to act the same as direct-attach storage, i.e. a digital storage system directly attached to a server or workstation without a storage network in between (Baker, R, Massiglia, P, 2002). In this way data can be stored more manageably as well as demonstrating greater capacity and availability together with improved performance.

1.5.5 Application Virtualization

Deployment always leads to the repetitive act of troubleshooting new problems and maintenance of new applications and will incur extra work for any IT professional. This model of virtualization allows better understanding of deploying applications. It also removes all the complexity for the user leaving only a trace of the operating system in use. It takes all the headaches away from the end user, e.g. the installation and uninstallation processes (Portnoy, M, 2012). Also this method makes it very easy to deploy many applications. Large organisations must manage many different applications and must consider the cost that is involved when newer versions are released, especially when they then have to be installed on all computers. This task would make it easier for them to manage as well as cost savings. Finally another reason for using this method is when it comes to the interaction between different applications. When uploading or upgrading certain applications, there is the possibility that they will not function as previously as they conflict with another program. Currently there are solutions to help with this problem within this virtualization method that the user/organisation need have no worries.

1.5.6 Desktop Virtualization

Virtualization has changed the desktop just like the server. For many organisations, desktop computing is becoming very expensive and in some cases inefficient. Many IT staff may be required to deploy, upgrade, maintain PCs in large organisations, which again relies on added resources, i.e. up to date hardware, software, and manpower, especially if there is a help desk that needs staffing. Running virtual desktops will reduce network traffic and broaden network resources (Portnoy, M, 2012).

Therefore, the possibility of a complete computer environment for the desktop has only become a possibility in recent years. Several organisations have already introduced this concept, which appears to be working well. One example was that in August 2010, Kingston University, London, introduced new software so that both staff and students would have virtual access via their desktops (www.kingston.ac.uk). They found that this method allowed them to deliver a more reliable learning experience globally as well as locally at any time of the day.

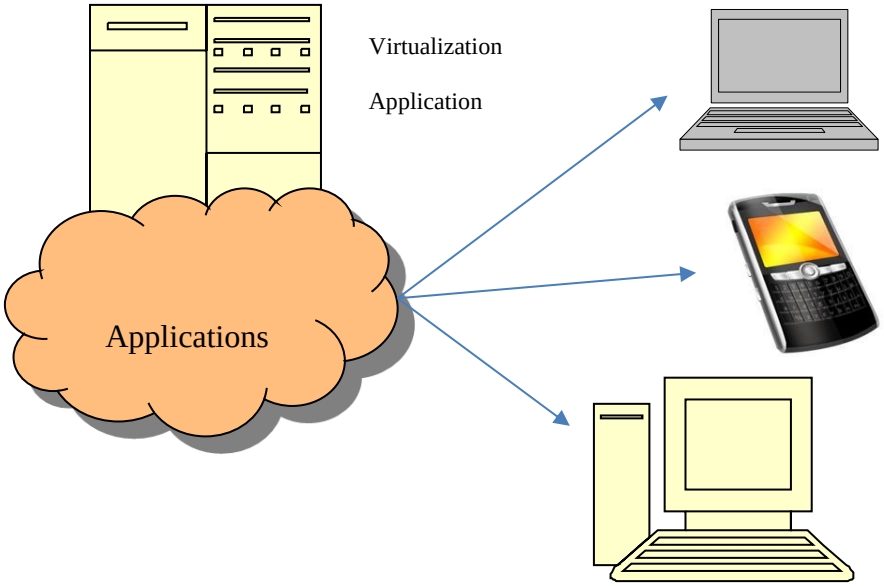


Figure 2: Desktop Virtualization

So why use desktop virtualization? First it allows the user to use software remotely. It also enables the user to experiment with any applications or programs without damaging the live computer (Figure 2). Thirdly saving of money, space and power are all important benefits. Fourthly the user never needs to buy any products to upgrade their computer. A final benefit is that, given advances in network and hardware performance, it is so much faster than a live computer and there are many more options to experiment with. Currently there are a few virtualization software programs that can be downloaded for a free trial, i.e. VMware Player 3; VMware Server; Microsoft Virtual PC 2007 and Sun Virtual Box. However, the decision on which to choose ultimately would lie with the organisation and a challenge for the IT professional.

However there may be users who do not feel as though virtualization is for them, i.e. those who find it difficult using new technology or accepting a new away of working. They may also include those who do not like to try new things; those who are frightened of making mistakes on their computer. These barriers could be remedied with training and addressing the advantages of using new technology, e.g. online storage – Google Drive; Sky Drive and Apple iCloud. Change management can often be difficult to implement.

Forward thinking organisations see Change as "Growth", whereas traditionalists see Change as "Pain" (Mateas, R, C, Kleiner, B, H, 1999). Therefore the most important factor in change is communication. Without communication and discussion, how can anything change? How do organisations know how the employee will react to change? It can be a slow process, but if the organisation has the backing of their employees, then surely this can only be a win-win situation depending on its acceptance. This also applies to virtualization. To overcome any resistance, improved communication is necessary to overcome barriers. A comment made by an IT manager at Stanford University stated:

"Virtualization is too good to be true". (www.networkworld.com, 2007)

It seems that virtualization at first glance can appear confusing and then users become astounded at the non-existent difference between the characteristics of a virtual machine and the physical one. With the emphasis on reduction of costs together with greater efficiency and productivity, surely resistance can be broken down once the benefits are realised. Users of virtualization should be able to understand the need for moving towards new technology otherwise there is the possibility they may get left behind by others in the future. By not advancing, jobs may disappear and organisations may close all for the sake of not moving forwards. Also it may be necessary to move a person from a particular role if they continue to have a negative attitude to new technology. John Henry (1994) suggests that when end users are involved in any change, they are more acceptant as they then have a "vested interest".

1.6 Chapter Summary

Chapter 1 briefly explained who the University Campus Oldham is and outlined the intention for this thesis. A brief summary was given of the contents and it looked at the background to virtualization together with a brief description of the different virtualization models and how the virtual desktop could be an advantage to both the academic staff and students. This chapter also outlined its aim and objectives together with setting the research questions. It was determined that the UCO needs to look at ways to improve the way it delivers its services, especially in view that they accommodate both local and overseas students. As was demonstrated in the case of Kingston University, this process

has already begun in educational establishments. New technology is ever advancing and education as to move forward also.

Chapter 2: Literature Review

Research literature review has been defined as:

> *"a systematic, explicit, and reproducible method for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars and practitioners" (Fink, A, 2005).*

Research review looks at different viewpoints from a variety of sources and then interpreting and evaluating the information obtained. The findings should then assist with the research project being undertaken. In order to help the researcher, the following may need to be considered:

Research Questions: these questions should help to direct the review.

Bibliographic Database: academic articles, books, reports can help to provide information to assist with answering the research questions.

Search Terms: using specific phrases and words can aid in the location of articles, books and reports appropriate to the research being done.

Application of Screening Criteria: this allows the researcher to filter out irrelevant material by applying certain search factors, e.g. relevance to study.

Starting the Review: the review allows the researcher to look at all information gained to see what can be used to assist with the research.

Amalgamation of the Results: the results are collated and analysed.

So why undertake a literature review? The review looks at other research reports, which should provide a setting for the research to be undertaken. Also it detects good practice already taking place and offers a list of references (Birmingham, 2000). Finally a good literature search should be able to summarise; evaluate; describe; clarify and incorporate research of others and allows the researcher to understand the research topic in greater depth and whether there is data available which will be supportive.

Using the above approach the Technology Acceptance Model, Usability Studies and Application Virtualization will be reviewed.

2.1 Technology Acceptance Model (TAM)

The aim of using the Technology Acceptance Model for the UCO is to predict whether the staff and students can gain an understanding of the virtual desktop and be confident in using it. The theory behind the Technology Acceptance Model (TAM) involves looking at the way one perceives the usefulness of new technology together with the way the user's intention to use a new system or product is perceived (Davis, F., D. 1989). Fred Davis created the TAM model (Figure 3 3) based on the Theory of Reasoned Action (TPB) (Fishbein, Ajzen, 1975), which looks at beliefs, attitude and behaviour towards new technology.

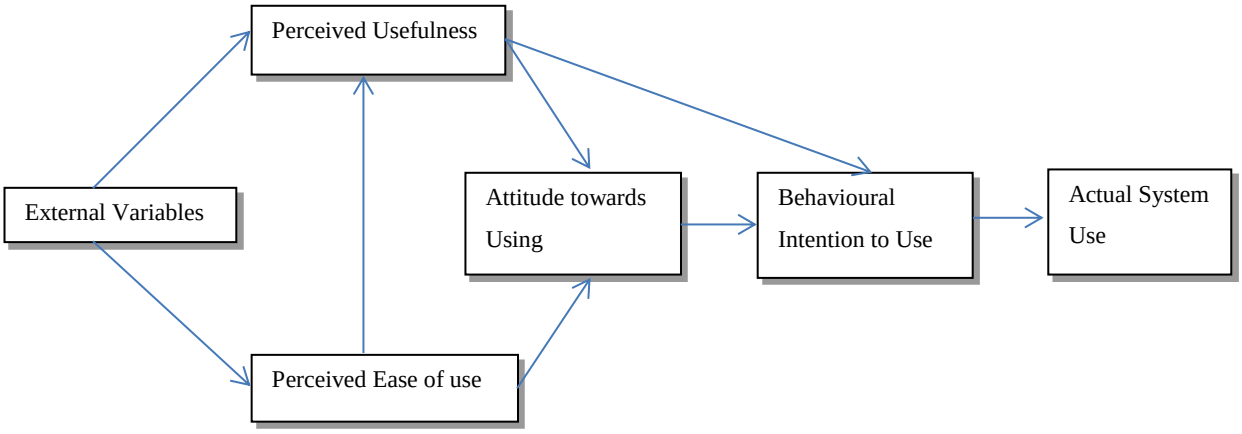


Figure 3: Technology Acceptance Model (Davis, F., D. 1989)

Venkatesh et al (2003); however developed three further TAM theory models by extending the original model with further constructs, e.g. effort; performance expectancy; social influence; experience; job relevance etc. (Figure 4, 5 and 6)

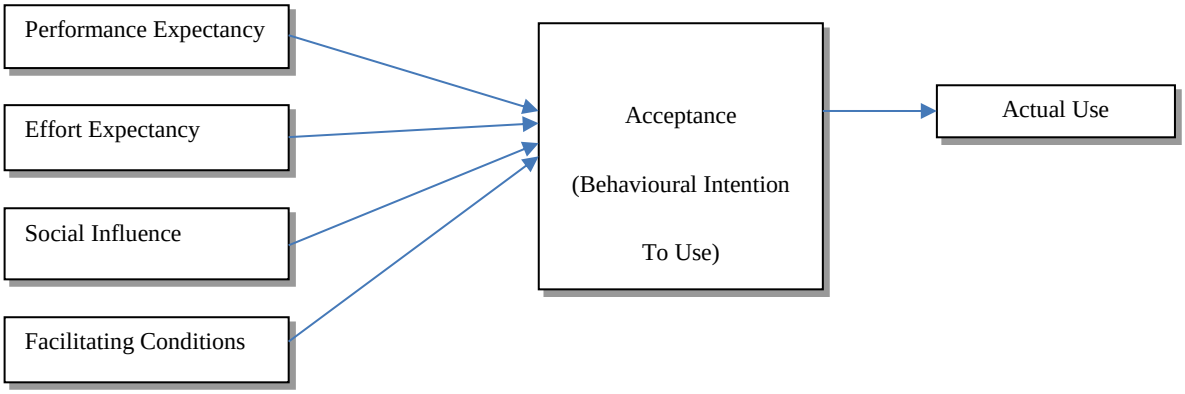


Figure 4: Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al, 2003)

The UTAUT although limited is an important concept having been developed from eight major theories that were tested globally (Im et al, 2010). An example of its application was to use the UTAUT model to determine whether culture would have an impact on technology acceptance. The UTAUT model consists of four main variables, i.e. Performance Expectancy; Effort Expectancy; Social Influence; and Facilitating Conditions. Im et al (2010); however felt that Culture also plays a part in adoption and use of technology. Therefore using this model they undertook studies between Korea and the United States of America (USA) to see how culture affects the way people use information systems. The results showed that social influence was greater in Korea, which was expected; however behavioural intent to use was greater in the USA than Korea. This demonstrated that the Americans were more likely to adopt new technology better that their Korean counterparts.

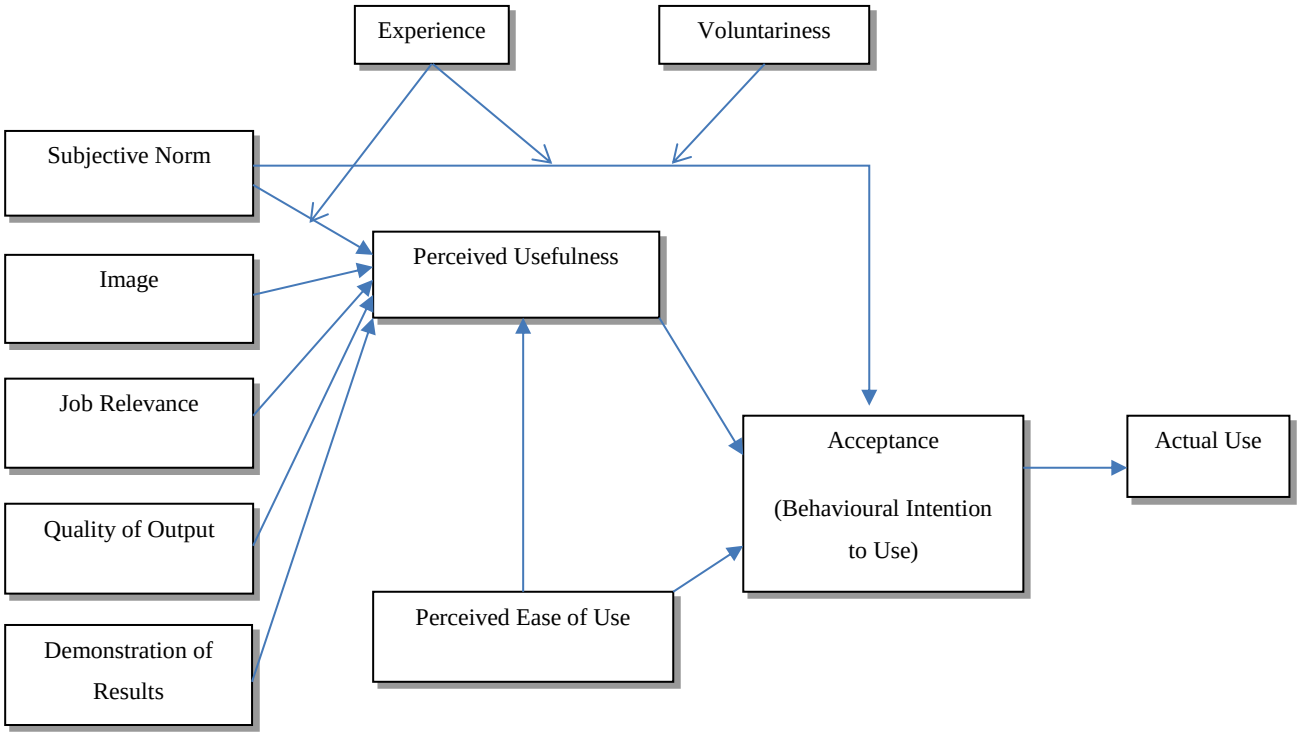


Figure 5: Technology Acceptance Model 2 (Venkatesh et al, 2003)

TAM 2 (Figure 5) is an extension of the original TAM, which now includes external variables. These include two theoretical processes, i.e. social influences and cognitive instrumental processes (Venkatesh, V, Bala, H, 2008). These variables can affect the results of any research being undertaken.

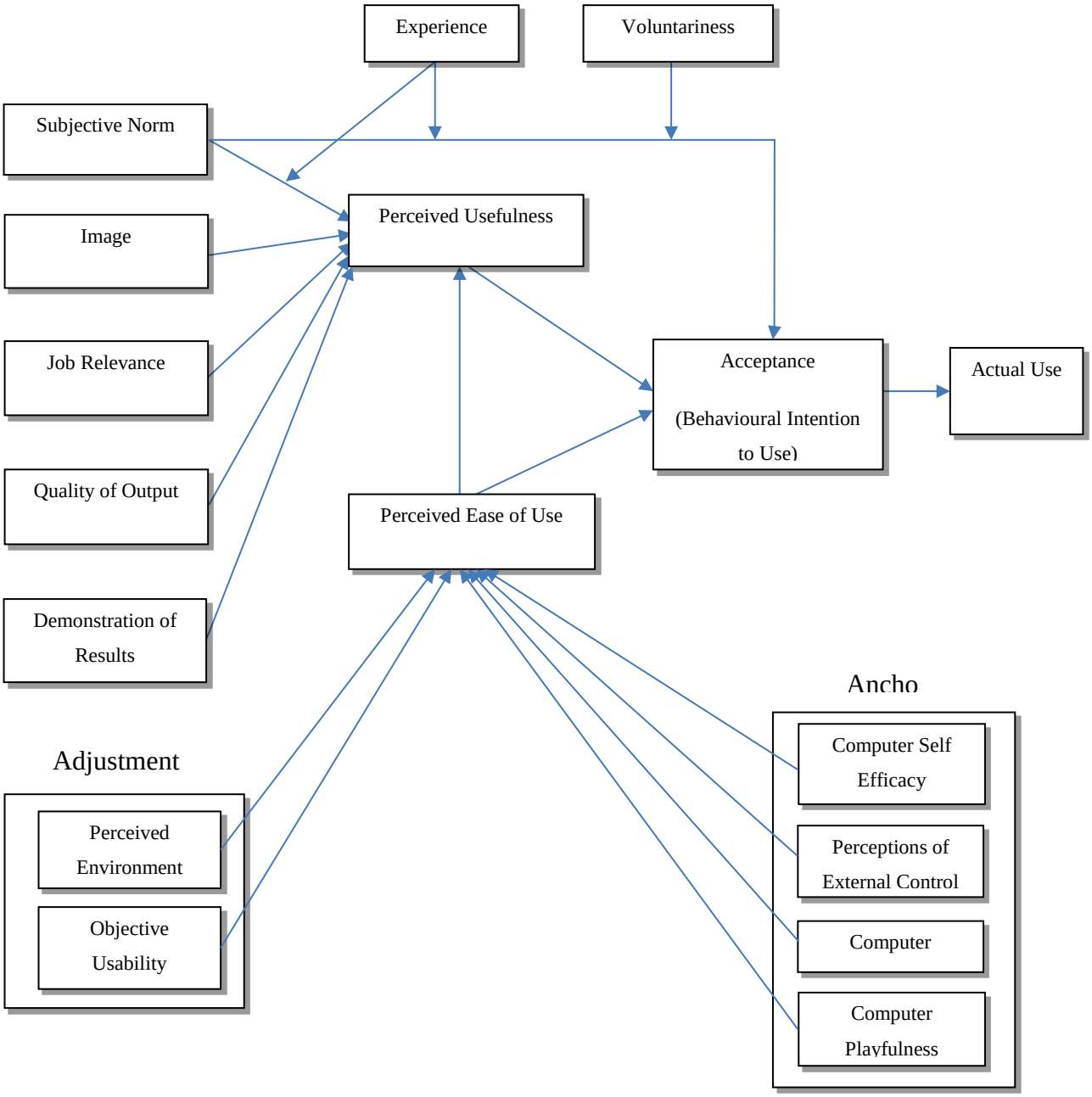


Figure 6: Technology Acceptance Model 3 (Venkatesh et al, 2003)

TAM 3 (Figure 6) is an integrated model of using TAM 2 and the elements of perceived ease of use: computer self-efficacy; perceptions of external control; computer anxiety; computer playfulness; perceived enjoyment and objective usability. A definition of the

different variables can be seen in Appendix 2: Definitions of TAM Variables and Related Models.

TAM has been reported in many articles regarding information systems since F D Davis's article: A Technology Acceptance Model for Empirical Testing New End-User Information Systems (1986). An Extended Technology Acceptance Model was used in Australia to determine whether self-service banking could be implemented (Rose, J, Fogarty, G, 2006). The results showed that senior bankers were in need of training in order to improve their confidence and to be competent enough to introduce the new self-service system (Charness, N, Park, D.C, Sabel, B.A, 2001). As well as banking TAM has been used to explore users' intention to use the wireless internet. Lu et al (2003) undertook this research in the early 2000s as it was becoming more apparent that wireless internet was increasing in popularity via mobile devices. This meant that there would be another method of communication, allowing more time spent on business and daily activities. Their research looked at the complexity of the technology; individual differences; social influence; ease of use; user perception of long and short term use and whether the user would embrace wireless internet for mobile devices. The results showed that this model can be modified as needed depending on the studies undertaken. Also they recommended:

Only those who currently use mobile devices should be targeted

- A self-reporting survey would be undertaken
- Measurement scales would need to be developed. This was due to the fact that there were only instruments available for student samples and business users only
- Structural equation modelling procedures were to be used to discover any underlying variables (Diamantopoulos, A, 1994).

("*Structural equation modeling (SEM) is a multivariate statistical framework that is used to model complex relationships between directly and indirectly observed (latent) variables. SEM is a general framework that involves simultaneously solving systems of linear equations and encompasses other techniques such as regression, factor analysis, path analysis, and latent growth curve modeling". Stein et al, 2012)*

It is also documented that TAM has been used to assess whether on-line learning could be accepted by users. In 2005, Liu et al undertook this research to see if students would adopt on-learning, which should make their studies more efficient. Their results showed that the acceptance rate was very high with regards to perceived usefulness.

So why use TAM? As Davis et al (2000) explains, TAM is used in order to determine whether any new information technology will be accepted or rejected and that results have shown to be very reliable. Therefore due to TAM's effectiveness as a theoretical model for use behaviour, it was used to demonstrate whether students and staff at the UCO would accept and use a virtual desktop (Figure 7).

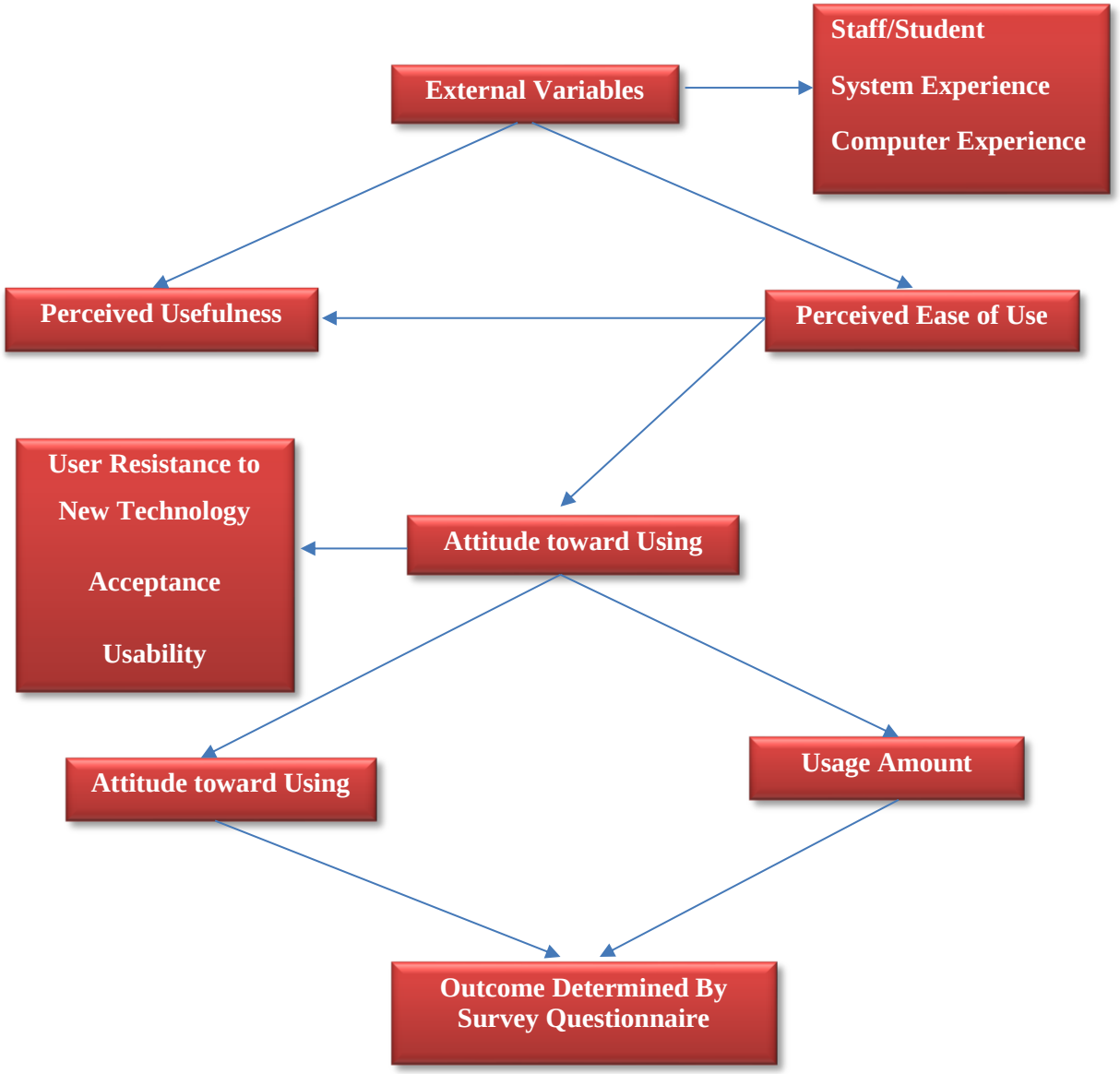


Figure 7: Technology Acceptance Model (TAM) for the UCO Virtual Desktop

In order to develop any new technology it is important to have a clear definitive description of the proposed benefits. This will be critical in obtaining accurate and worthwhile responses from the intended end user. As a result it was determined that the following statement would be given at the beginning of the survey questionnaire to assist the end user:

"This research aims to look at the possibility of introducing desktop virtualisation at the UCO for both staff and students. Desktop virtualization will allow you to use any operating systems, e.g. Windows; Linux; Mac OS X; from your own home computer without affecting your home computer. This means that you could access any programs via the University network as if you were actually in the building. Therefore all those expensive programs could be used without having to buy them. It would be free to use and has been known to work faster than a physical computer. There would also be the ability to store all your work on your personal university file, without having to save on external hard drives and physically going into the university to download all your files. However you would need an internet connection, may get logged out automatically, may not have as high performance as your home computer, don't save local copies and may prefer to be at the UCO to work."

The text aims to briefly inform the user of what the service is and how they would benefit from it. It is also intended to provide a realistic understanding of the technology and its capabilities.

In conclusion, previously mentioned studies have shown that TAM has been a useful theoretical model when implementing information systems. It helps the researcher to understand and explain user behaviour as well as providing results that are statistically reliable.

2.2 Usability

Usability in the International Organisation of Standardisation (ISO) 9241 is defined as:

"The extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use".

Unfortunately this definition does not take into account the fact that usability changes over time. However usability has five attributes, which can be measured: Efficiency; Errors; User Satisfaction; Learnability and Memorability. Some of these attributes may be more

important than others depending on what is to be applied, e.g. if the application is time critical then efficiency is crucial in order to prevent errors.

2.2.1 Different Usability Evaluation Methods

There are three different ways of evaluating usability – User Centred; Heuristic and Model-Based. A combination of both User-Centred and Heuristic methods have been used for this research.

User Centred: Looks at ways of developing a process, which allows the problems encountered by users to be ensnared when using new technology and applying a software product to assist with this. Again this method is divided into two types of user evaluation, i.e. Formative and Summative. Formative evaluations involve obtaining user feedback in the early stages of any designs or concepts. This means that evaluation needs to take place fairly swiftly so that changes can be made as soon as possible to any prototypes etc. Summative evaluations are more formal and document the characteristics of the product being evaluated. A good experimental design is crucial for summative evaluation.

The main advantage to this type of usability evaluation is that it relies on user involvement. Unfortunately it can be very time consuming and costly. Also it can be difficult finding enough users to be representative of the evaluation.

Heuristic: Studies show that Heuristic evaluation (Nielson, J, 1994) appears to be the most popular used evaluation method. It is less time consuming and inexpensive than user centred and it uses a small set of ten evaluators but quite often it is common to only use five:

- Visibility of system status
- Match between the system and the real world
- User control and freedom
- Consistency and standards
- Error prevention
- Recognition rather than recall
- Flexibility and efficiency of use

- Aesthetic and minimalist design
- Help users to recognise, diagnose and recover from errors
- Help and documentation

One advantage to this method is that it can be used in the very early stages of the development process. However it can be equally difficult in the summation of any findings from diverse evaluators as they could testify to problems at different levels. This method also indicates that all usability problems may not be equal. This means that the more serious problems may need to be prioritized by the development team. It must be noted here that manuals or instructions will need to be developed for the end user due to limited user involvement.

Model – based: There are a few different model based evaluation methods, including –

GOMS (Goals, Operators, Methods, and Selection) Model

This evaluation method relies on data developed from human perceptions, memory and cognition. It also includes – short and long term memory capability; visual and audio processing; and cognitive and motor processing. With these attributes researchers are able to undertake an evaluation "*based on predictions of performance from the model*" *(Scholtz, J, 2004)*. Unfortunately this method is unable to evaluate possible errors but to just to evaluate the technical characteristics of usability.

EPIC (Executive, Process, Interactive, Control) – this method mimics the human system of perception and motor performance.

ACT-R model – aids in the evaluation of gathered information from websites, which is found to be of value.

ACT-IF model – this evaluation method looks at users' behaviour when they make decisions as to which links of the web they go to in order to fulfil their research goals.

These model based methods are less costly than others. Unfortunately these methods are time consuming as it is necessary to observe users when they perform certain tasks, but vital to see how accurate the model calculations are likely to be.

In 2010 Viitanen et al undertook a usability study in Finland to see whether a group of physicians could use a single information system within the health informatics field in order to inspire them towards a more holistic approach. Using both a user centred and heuristic approach, they focused on the user, systems, activities and environment. Once the questionnaires had been analysed, it emerged that a number of usability problems were evident between with the information system and their routine work. However this information showed how critical information systems are for the physicians.

Although this report identified usability problems, it seems that studies do show a variety of usability problems within the virtual reality environment. Sebok et al (2004) discuss technical issues with navigation. This research led to them re-evaluating which factors were essential in improving navigation, i.e. flexibility; feedback; constraints and control dynamics. Another reported problem is usability within a culturally diverse environment. It would appear that usability problems are likely to occur more in the Far East, i.e. India, China or Malaysia (Clemmenson, T, 2012). This study showed country specific problems, e.g. in China there were problems with Microsoft Office Word in general regarding characters, background, print preview, and colour etc.

It is clear from studies that usability needs to be at the forefront of any new development process. One usability issue with virtual reality is the environment. Bowman et al (2002) describe such an issue with head mounted displays, whereby the user is unable to see the environment of the physical world. The solution would be to make sure that users cannot injure themselves, i.e. tripping over objects or bumping into walls and ensuring the surrounding environment is safe. There is also the unpredictability of the network especially when more there is more than one user. A multi-user system could also cause usability problems as each user will have their own input and output devices.

2.3 Evaluation of TAM and Usability

It is easy to see that there is a relationship between usability characteristics and perceived usefulness (PU) & perceived ease of use (PEU). PU focuses on the end users' personal insight of productivity, job performance and effectiveness with the support of IT.

TAM, however, has been shown to be a suitable theoretical model to use when determining a user's behaviour towards new information technology. Not only has it been used in many researches as previously stated but it has shown to produce reliable results. Even though it has been successful for many projects, it is not without flaws. Turner et al (2009) undertook a study to show whether TAM could actually predict actual use. The results showed that problems could arise if the research questions were not set adequately, i.e. PU and PEU may not be good predictors of usage due how diverse the results could be. Other factors affecting IS (information systems) satisfaction can be seen in Appendix 3: Factors Affecting Information System Satisfaction (Bailey, J. E. Pearson, S.W, 1993).

However, from the research undertaken to date, it appears that when any new information technology is to be implemented, TAM is one of the main models chosen. Despite this there are some factors to consider first:

- Research would bring better results within a business environment even though there are costs involved, as more empirical results could be achieved.
- Although most studies looked at systems and software development, there appears to be a need to look at business process applications also.
- TAM measures self-use variances rather than system use, which is will not be an accurate measure, and therefore can only act as a comparative value.
- Finally, any new information service should consider how it could affect the organisation as a whole. Change management and innovation have been known to make a great impact on outcomes; therefore managers need to be aware of this before implementing any new strategy (Legris et al, 2003).

When it comes to evaluating usability methods, it is important to identify performance measures. In 1995, Bastien and Scapin identified these three basic performance measures: Thoroughness; Validity; and Reliability. However Hartson et al (2010) felt other metrics should be added, i.e. Effectiveness (a grouping of thoroughness and validity together); Cost Effectiveness and Downstream Utility.

Thoroughness - was defined by Sears in 1997 as:

> ***"Number of real problems found ÷ Number of real problems that exist"*** *(Hartson et al, 2010)*

This measure can also be used to look at the severity of problems using the same equation, but Nielson (1994) advised caution regarding reliability as group results were better recorded than individual ones.

Validity– was again defined by Sears (1997) as:

> ***"Number of real problems found ÷ number of issues identified as problems"*** *(Hartson et al, 2010)*

Using this measure ensures that results will yield 100% validity for all contributory methods of usability.

Effectiveness – as previously mentioned is a combination of both thoroughness and validity, i.e. *thoroughness x validity*.

Reliability– measures the consistency of testing results. Usually this is based on an agreement between two or multiple sets of ranking data (Hartson et al, 2010). Reliable data therefore will depend on how valid any testing is. Also increased thoroughness should improve the reliability of data collected.

Downstream Utility – this measures the overall usefulness of any usability data collection.

Cost Effectiveness - this measure determines whether the undertaking of a usability study would be less expensive by using maximum effectiveness. However both cost and performance will need to be assessed, but it should be noted that it needs to be both consistent as well as accurate in order to obtain the result required.

2.4 Application Virtualization

What is application virtualization? Application virtualization programs are the operating platforms, which run and manage the virtual machines as well as run the virtual programs

from the live desktop. The thinking behind this is to remove many of the support-draining configuration problems from the live desktop applications (InfoWorld, 2007). With application virtualization, there is no need for the use of apps on the PC desktops; in the same way that desktop virtualization enables any user to enter the entire desktop environment.

There are three styles of Application Virtualization – Altiris; Microsoft and Thinstall. Figure 8 demonstrates how the Altiris approach uses a filter driver to divert input/output demands from all the operating processes and then examines them to decide which ones should be re-directed to its virtual system file cache.

Altiris:

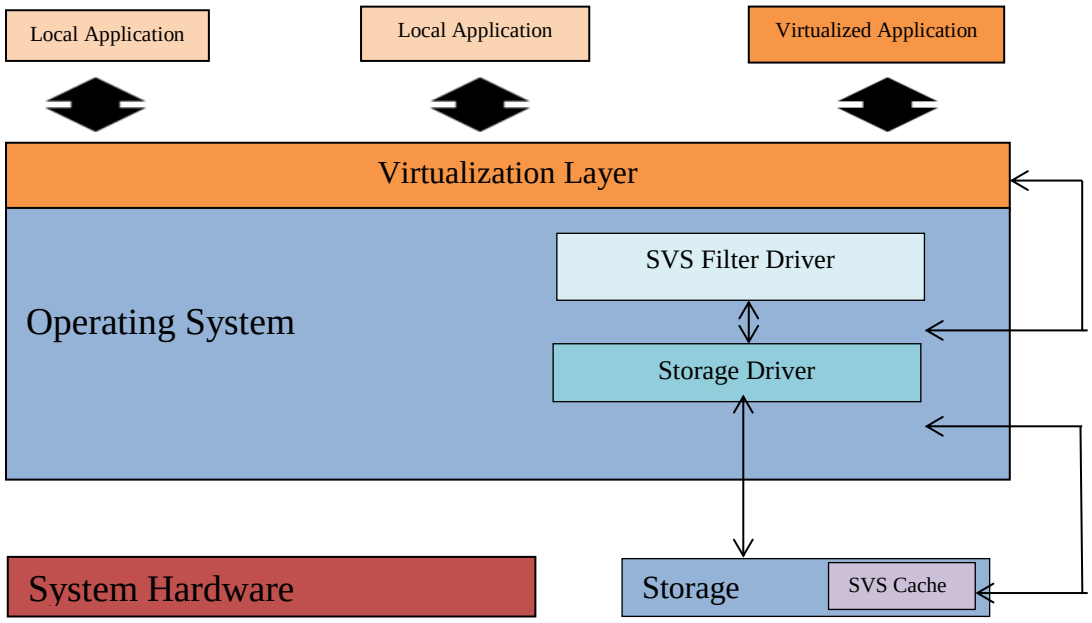


Figure 8: Altiris SVS (adapted from www.infoworld.com . 2007)

Microsoft SoftGrid:

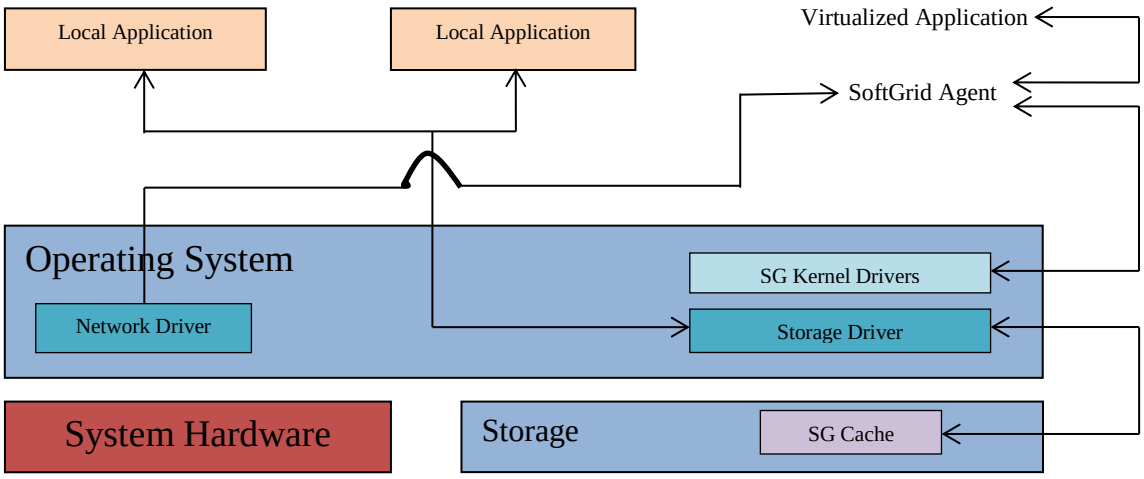


Figure 9: Microsoft SoftGrid (adapted from www.infoworld.com . 2007)

The next approach is the Softgrid (Figure 9), which shows how this application restricts the way it re-routes it's checking system to the virtual processes that are overseen by the user and kernel mode components.

Thinstall:

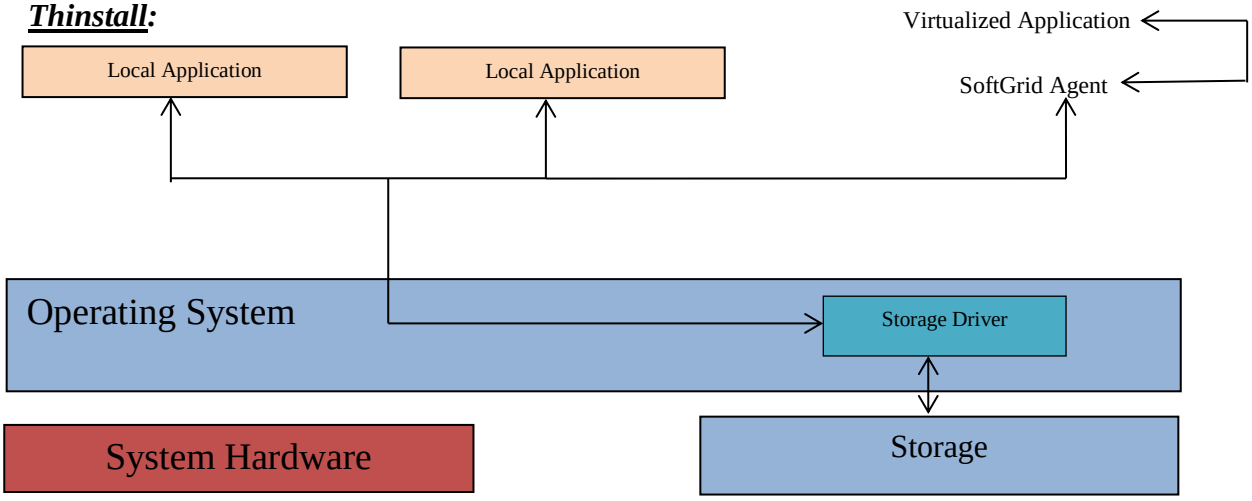


Figure 10: Thinstall (adapted from www.infoworld.com . 2007)

Finally Figure 10 demonstrates how the Thinstall application takes away the local operating system by surrounding its virtualization logic inside the newly created application programs.

As well as the applications, there may also be the requirement for an isolated virtualization environment to be run on a live PC, known as a virtual machine. Every virtual machine would run the same as a live PC, i.e. with a memory; CPU; hard disks; graphic cards etc. Langmann and Arts (2012) state that it has been recognised virtual machine shave some disadvantages:

Decrease in performance

- Cannot focus on all hardware or match it
- Can be a problem accessing the graphics card
- A partnership of servers could be at risk if just one virtual machine fails
- Due to the complex nature of virtualization, it may be necessary to invite further expert advice for its installation and operation

The virtualization software currently available to run on virtual machines is:

Microsoft– this is a free download from Microsoft. It allows the virtual machine to run different operating systems on the same desktop, including DOS, all versions of Windows down to Windows 95 as well as a Mac version.

Parallels– this software is aimed for Windows and Linux as well as for the Mac. It also has hypervisor technology built in that allows for the performance of input/output to reach new heights.

VMware– the aim of this software is to provide virtualization form the data centre directly to the remote user.

The Citrix systems have been used for quite some time in server based computing but reportedly sees itself as a pioneer in application virtualisation (www.infoworld.com, 2007). However its future success will depend on whether Project Tarpon (for faster application streaming) continues to be an example of the services Citrix are developing in order to maintain its place as a dominant player in the application virtualization field. Its

main aims were to reduce the number of software licenses required for staff and to speed up the time applications are delivered (Enterprise Management Associates, 2006).

Finally, as virtualization is easy to implement and becomes more in demand, there are some things that need to be considered.

1. The age of the hardware, which is to support virtualization may need to be addressed. Some software may require hardware upgrade; however Microsoft and VMware an still run on older hardware platforms (Otey, M. 2011).
2. It is important not to include virtual hard disks when the host is performing an antivirus scan. If is this ignored, it could reduce the performance of the virtual machine.
3. Individual users should still back up their data at local level for data protection but can still use the host back up system in case of need for emergency recovery as the host image can be restored on a different virtualization host.
4. It is imperative that the virtualization host has live security due to the number of possible users accessing the service.
5. It is not necessary to keep the default settings of the host. When settings are changed, one has to remember set the workload of the virtual machine to reflect the settings of the network, disk, memory and CPU.
6. It is better to have one virtualization host for each virtual machine. This will enable a higher utilization of the hard disk drive than a live computer and in this way the host is able to notify the user on the machines utilization levels.
7. It is important to remember to have enough host memory for both the virtual machines and virtualization as the live machines still rely on physical RAM memory.
8. Another point to remember is to have sufficient host network adapter cards. This is due to the fact that in the server environment, the network bandwidth is channelled through the host's network adapters from all the virtual machines. Too much traffic from the virtual machines could become a big strain on a few adaptors.

2.5 Chapter Summary

Chapter 2 looked at a review of the literature pertaining to the Technology Acceptance Model, Usability and Application Virtualization. It is evident that TAM has been used in a variety of environments as a way of evaluating how users would accept new technology, i.e. higher education; banking; medicine etc. The different TAMs enable the researcher to decide which one is the best for any one particular project. The different usability models show that again this is a necessary tool to determine how users perceive new technology to be useful and effective and whether ultimately they would accept any new technology that was to be introduced. An evaluation of both models was looked at and it was decided that a combination of both TAM and Usability models usually suits most projects. Finally a look was taken at application virtualization. Research showed that it can lower costs of desktop management by being able to re-establish new applications quickly; more major companies are moving into this field, i.e. Microsoft, Citrix, VMware, and Symantec; and it allows the configuration of any application the user requires for the virtual desktop. Finally possible pitfalls were reviewed, identifying those which should be avoided when implementing application virtualization. Chapter 3 will now show how the research approach has been developed, in order to avoid these pitfalls and acquire the desired outcome.

Chapter 3: Research Methodology

The previous chapter involved looking at available academic literature pertaining to the Technology Acceptance Model and Usability and how they allow the researcher to:

1. Identify opposite viewpoints
2. Identify openings in the current knowledge base
3. Save time by avoiding others' mistakes
4. Be able to build on the knowledge available
5. Be part of a network, providing useful material from others in the same field of work
6. Broaden own knowledge in chosen topic
7. Identify the most informative and original pieces of work related to this research
8. Provide evidence around the chosen topic with other related work that has been undertaken
9. Provide information and concepts that may be relevant to the research being undertaken
10. Provide other methods of research that could be useful to the researcher

Miles and Hüberman (1994) visualised a research methodology in the same way as putting a jigsaw puzzle together; however, Kaplan (1973) suggests that methodology both describes and analyses. There is a clear difference as to how different methodologists view things. Setting different parameters allows for the researcher to decide which is the best suited for the work to be undertaken. Once the appropriate methodology has been chosen, in this case using both the Quantitative and Qualitative methods, it will shed light on the beliefs and results as well as limitations and resources. However, it has to be noted that research can produce unexpected results and that is when it becomes more interesting.

In order to undertake a good piece of research, certain characteristics might be required as Campbell et al (1982) set out. These are:

- ***Activity and Involvement*** – it is imperative that the researcher always maintains contact with colleagues when out in the field.
- ***Convergence***– when one or more ideas come together to formulate a plan

- ***Intuition***– having the knowledge to understand if the work being done is appropriate, timely, relevant etc.
- ***Theory***– be aware of the theories supporting the research
- ***Real World Value*** – problems encountered in the field resulting in concrete ideas.

However Saunders et al (2008), suggest using the research 'onion' model. This model enables the researcher to look at different variables, which could hinder or benefit any research, e.g. how to undertake sample survey; what questions need to be asked; and who will be part of the research group, etc. The answers could have a big impact on the end result.

3.1 Methodology

Prior to any research there are certain questions to be asked - What is the topic? Why is the information needed? How is the information to be collected? What is the information going to be used for? The most important factor is suggested by Cohen, Manion and Morrison (2000) that all research should be fit for purpose. So what methods are required to obtain the information needed? This will be determined in due course as research can have different meanings to different people. But no matter how many definitions there are, it appears that most definitions indicate that research is systematic; methodical; increases knowledge; and involves investigation. Therefore it is important that a research strategy or plan is formulated.

In order to undertake both primary and secondary research, it is important to find the truth about any one given subject, in this case virtualization. So what is truth if the German philosopher Nietzsche states "*there is no such thing as the truth*"? It appears that there is a great variance in what philosophers define as being the truth (Vanzo, A, 2010). Truth is something that is accepted for being real produced by truth makers. As this topic area is too vast, it is left up to the researcher to accept academic literature as being truthful. Although there will be differences in the literature, there will be a common thread that should assist anyone undertaking research in any one particular field. Information gathered will be either subjective or objective and needs to be determined, which is

appropriate to consider for one's own project. Finally it is also necessary to consider both deductive and inductive research.

Deductive research uses theoretical and conceptual frameworks before testing. It is based on concepts, rules, operationalization, instructions and corroboration (Johnson, G, 2005). Popper (1972) argues that theories can be falsified and cannot always be proven to be true and therefore defined scientific theories as – *'capable of empirical testing and scientists should not confirm their theories but try their utmost to falsify them'*. Gill, J. and Johnson, G. (2005) however, suggest that after all this, a core theory is left that has not been disproved. The problem with deduction, however, is that not everyone will agree with the concepts and assumptions made through the notion of the social sciences. This deductive research involved looking at the theories already tested surrounding the technology acceptance model and usability studies.

Inductive research is the opposite of deductive research, which involves looking at the theory behind what has been observed, compared to observing the experiential aspects. These two methods of reasoning are very different. Inductive research is more exploratory and open ended, whereas deductive research is more concerned with testing theories. Therefore the inductive research undertaken was by means of computer user survey questionnaires, which enabled the researcher to see how users understood and were receptive to the possible introduction of desktop virtualization within the UCO.

3.2 The Research Onion Model

Saunders et al (2008) recommended that when contemplating any research, certain criteria need to be considered, e.g. whether interviews are to take place or questionnaires are to be administered. Also if there are any problems relating to data collection techniques. In view of the various criteria to be considered a research onion model was devised showing that any research has various layers that need to be peeled away. As can be seen by Figure 11, these layers make up a variety of issues that need to be considered.

This method is useful in a variety of settings. WIPRO – a global energy consulting organisation produced a white paper on the improvement of operational safety using the

onion model (www.wipro.com). It allowed them to look a four "layers" of leading practices to improve their operational safety to make it more effective. In 2011, the University of Iceland presented a paper at a conference regarding patterns of electoral reform, again using the onion model. This allowed them to look at how the analysis of the mixed reform packages were structured (Jacobs, K, 2011). Finally within the education sector, the onion model was used to look at levels of change needed in order to look at teachers' conceptions of self-regulated learning (Krecic, M, J. Grmek, M, I, 2010). These levels involved looking at behaviour; competencies; beliefs; identity; and mission. So applying the model to this research, seems applicable in view of the criteria, which needs to be considered, i.e. which Paradigms/Philosophy; whether to be deductive or inductive; whether to use quantitative or qualitative data or mixed method approach; and the type of data collection and analysis.

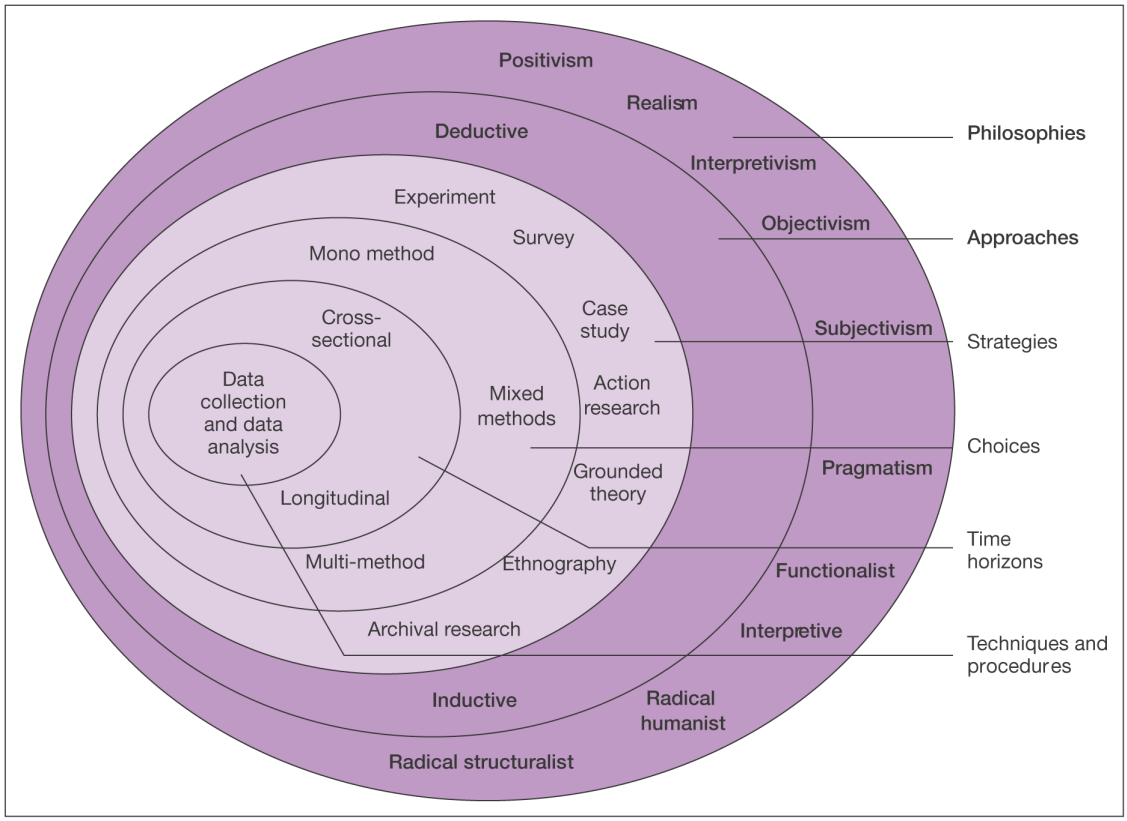


Figure 11: The Research Onion Model (Saunders et al, 2008)

3.3 Research Design

Research design involves devising the plan and procedure for undertaking any research. The researcher will then consider whether there are likely to be any research problem; research issues and any personal experiences. Bryman (2008) considered that there could be influences on the research design, i.e. Theory; Practical Consideration; Axiology; Ontology and Epistemology. Therefore a framework is needed for this research design. Such a framework includes research paradigms; philosophical worldviews; research strategies and research techniques (see Figure 12). Once the design has been chosen and implemented, all data is then collected and analysed and the findings should produce an end result, whether it is one expected or unexpected.

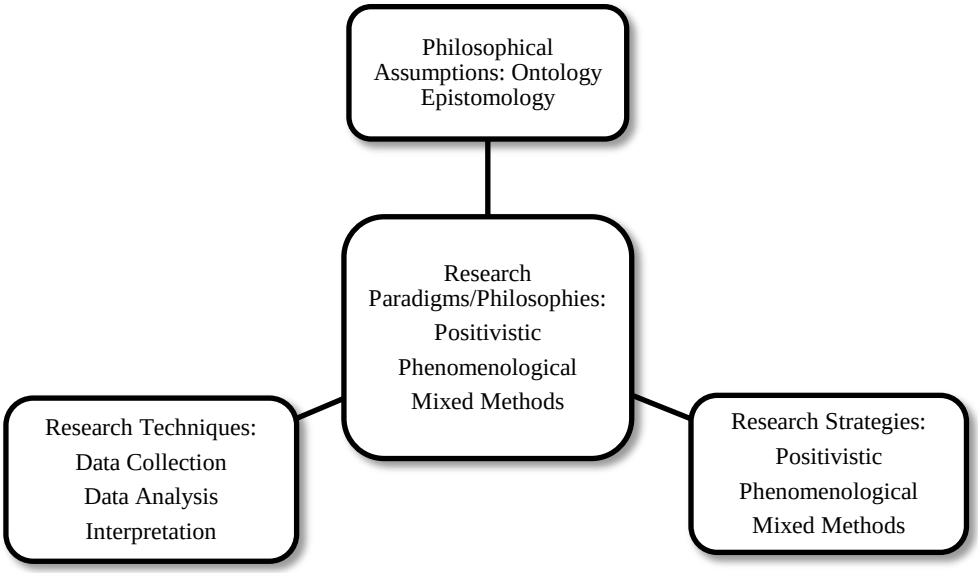


Figure 12: Research Design Framework (adapted from Creswell, 2009)

One definition of research paradigm is:

> *"To establish relationships between or among constructs that describe or explain a phenomenon by going beyond the local event and trying to connect it with similar events" (Mertens, 2005).*

However Saunders et al (2008) define research paradigm as:

> *"A way of examining social phenomenon from which particular understandings of these phenomena can be gained and explanations attempted".*

Although both these definitions are worded differently, they do in fact both mean the same.

Creswell (1994) refers to two main research paradigms – Positivistic (qualitative) and Post Modernism (quantitative), however Gephart (1999) outlined three research paradigm characteristics (Table 1). The researcher will adopt a certain paradigm depending on their beliefs and philosophy, i.e. Positivistic (objective) or Phenomenological (subjective). However there are a lot of philosophies based on Ontology and Epistemology & Axiology.

> *"Ontology is concerned with the nature of reality .....and assumptions researcher have about the way the world operates and the commitment held to a particular view" (Saunders et al, 2009)*

One aspect of Ontology is objectivism. It allows for impartiality when looking at reality from a social perspective and external factors that may be concerned with their existence. The second is subjectivism, which supports the fact that social phenomena are constructed from the perceptions and any ensuing actions of the social factors concerned with their existence (Saunders et al, 2009). In view of this, the Researcher has to seriously contemplate as to whether Reality is Objective or Subjective.

> *"Epistemology is concerned with the study of knowledge and what we accept as being valid knowledge" (Collis, J. Hussey, R, 2003)*

The epistemologist's view on Positivism is that they believe that findings, which can be measured and observed, can be seen as valid knowledge. In so doing they try to remain objective, which leads to a Positivistic Paradigm. On the other hand their view on Phenomenology is that any findings would be based on an individual's perception of reality. Also there appears to be remoteness between the topic being researched and the researcher, which leads to the Phenomenological Paradigm.

"Axiology, the science of human values, enables us to identify the internal valuing systems that influence our perceptions, decisions and actions - to clearly understand "why" we do what we do." (Hartmann, R, S, 1973).

Axiology is in fact the way the researcher looks at the way values have a role to play in research. The axiological assumption of a Positivist is that they believe that research is value free. In this way they are removed away from what they are researching. From the opposite end, a Phenomenologist sees that the Researcher has values. In this way they are fully involved with the research process and understand that values assist in recognising the facts and their interpretation.

	PHENOMENOLOGICAL	**POSITIVISTIC (QUANTITATIVE)**	**POST MODERNISM QUALITATIVE**
ASSUMPTIONS	Inter-subjective world which science can represent with concepts of concepts of actors; social construction of reality	Objective world which science can 'mirror' with privileged knowledge	Material world of structured contradictions and/or exploitation which can be objectively known only by removing tacit ideological biases
KEY FOCUS or IDEAS	Search for patterns of meaning	Search for contextual and organizational variables which cause organizational actions	Search for disguised contradictions hidden by ideology; open spaces for previously silenced voices
KEY THEORIES IN PARADIGMS	Symbolic interaction; ethno methodology; phenomenology; hermeneutics	Contingency theory; systems theory; population ecology; transaction cost economics of organizing; dustbowl empiricism	Marxism; critical theory; 'radical' perspectives PM: post structuralism; postmodernism; deconstructionism; semiotics
KEY FIGURES	Goffman; Garfinkel, Schutz; Van Maanen, David Silverman	Lorsch and Lawrence; Hannan and Freeman; Oliver Williamson	Marx; Habermas: Offe
GOAL OF PARADIGM	Describe meanings, understand members' definitions of the situation, examine how objective realities are produced	Uncover truth and facts as quantitatively specified relations among variables	Uncover hidden interests; expose contractions; enable more informed consciousness; displace ideology with scientific insights; change
NATURE OF KNOWLEDGE or FORM OF THEORY	Abstract descriptions of meanings and members= definitions of situations produced in natural contexts	Verified hypotheses involving valid, reliable and precisely measured variables	Structural or historical insights revealing contradictions
CRITERIA FOR ASSESSING	Trustworthiness	Prediction=Explanation Rigor;	Theoretical consistency Historical insights

RESEARCH	Authenticity	Internal & external validity, reliability	Transcendent interpretations Basis for action, change potential and mobilization
UNIT OF ANALYSIS	Meaning; symbolic act	The variable	Contradictions, incidents of exploitation PM: the sign
RESEARCH METHODS and TYPE(S) OF ANALYSIS	Ethnography; participant observation; interviews; conversational analysis; grounded theory development Case studies; conversational and textual analysis; expansion analysis	Experiments; questionnaires; secondary data analysis; quantitatively coded documents Quantitative: regression; Likert scaling; structural equation modelling Qualitative: grounded theory testing	Field research, historical analysis, dialectical analysis PM: deconstruction, textual analysis

Table 1: Research Paradigms (adapted from: www.division.aomonline.org)

As previously stated Creswell (1994) refers to two main research paradigms: Positivistic and Phenomenological. The traits of the Positivistic Paradigm tend to have the following traits: - takes a broad view from a sample population; decrease in validity; increased reliability; location is usually artificial; highly specific and precise data; tends to be too concerned with hypothesis testing; large samples are used; and quantitative data is used (Collis, J. Hussey, R. 2003)

However, the Phenomenological Paradigm has these traits: - there is a tendency to generalize from one situation to another; increase in validity; low reliability; expected location; data is in abundance and general; too concerned with creating theories; small samples; and qualitative data used. When setting a research plan it is necessary to decide which research paradigm is to be used as it is important to be objective (by not making assumptions) even though subjectivity may play a part?

3.4 The Research Process

The research process allows the researcher to map out how the research is to be undertaken and to determine whether any issues may hinder the process, e.g. ethical issues and/or

limitations. Also the researcher needs to decide if any sampling is to be undertaken and what form this will take.

Howard and Sharp (1983) proposes a seven step research process (Table 2):

IDENTIFY BROAD AREA
SELECT TOPIC
DECIDE APPROACH
FORMULATE PLAN
COLLECT INFORMATION
ANALYSE DATA
PRESENT FINDINGS

Table 2: Research Process (Howard, Sharp, 1983)

They stress the importance of taking extra time with each part of the process, in order to avoid problems later on. However it must be determined which process is required – Qualitative or Quantitative. Qualitative research is a collection of data involving numbers. It should be noted that the interpretation of this data can be limiting. Quantitative research although not involving numbers may give more clarity to the findings. As well as the two paradigms, Creswell in 2009 described the use of Qualitative and Quantitative Research.

Quantitative research is a way of challenging objective theories by looking at the association between the variables. The measurement of these variables enables the analysing of numbered data with the use of geometric processes. Also this research allows assumptions to be made regarding testing theories logically. Finally bias is prevented by the Researcher including some form of prevention.

Qualitative research looks at research from an individual point of view. Data is usually collected within the participant's location. Analysis of the data is inductively built from

the facts to the broadness of the topic, whereby the results of the data is interpreted by the Researcher.

Figure 13 shows the different characteristics of both Quantitative and Qualitative Data (Samuel, A, 2012). There are no strict rules as to which method to use but the consideration is if quantitative data is required then the paradigm to use is Positivistic but if qualitative date is required then the Phenomenological paradigm should be used. However, why does the Researcher need to rely on one method? Is there any reason why there could not be a mix of the two? In fact looking at the characteristics of both these methods, there could be occasions where some characteristics of both would apply. Therefore, would a mix of the two be an acceptable approach? Now that there is a Mixed Methods Approach, this could be the appropriate method for many researchers. In this instance, a mixed methods approach was used as the research has components of both quantitative and qualitative data. Two methods of research were undertaken, i.e. questionnaire and documentation, but before this the research onion model was used to look at the different layers of the research process.

Quantitative	**Qualitative**
➢ When looking for causes and facts ➢ Controlled measures ➢ Objective ➢ Predictive ➢ Outside Perspective ➢ Deductive ➢ Verification oriented ➢ Outcome oriented ➢ Specific ➢ Closed ➢ Assumption of a stable reality	➢ Understanding behaviours ➢ Observation without control ➢ Subjective ➢ Inside perspective ➢ Explanatory ➢ Descriptive ➢ Process oriented ➢ Holistic ➢ Open ➢ Assumption of a dynamic reality

Figure 13: Characteristics of Quantitative and Qualitative Data

3.5 Primary Research

It is documented that questionnaires or surveys are not very accurate (Oppenheim, 1996). This is usually due to certain factors, i.e.

- Return of incomplete questionnaires
- Incomplete survey responses
- Survey/questionnaires completed by someone other than the respondent
- Low response rate
- Falsified responses (those completing the forms 'just for the fun of it')

Even though there appears to be a lot of criticism regarding this method of primary research, it was decided that a feedback survey questionnaire would be the best method of sampling to use in this instance due to location and the numbers involved.

A feedback survey can be a good way to measure user satisfaction and possible acceptance of products/services. Focus groups or individual interviews were unrealistic as it can be difficult for staff to set time aside from their work, or for students to take out precious study time. Therefore, a survey questionnaire was decided on so that all would have ample time to complete at their leisure.

In order to undertake any form of survey, the researcher needs to consider the following;

- Question design
- How to administer the questionnaire?
- Sampling – size and who to be included
- Ethical issues
- Significance and any limitations (both theoretical and organisational)

See Figure 14 regarding the research choices made.

Question Design	The questions will consist of a combination of dichotomy (yes/no); multiple choice; and ones, which were measurable via the Likert scale
Administering the Questionnaire	The questionnaire will be sent via a link in an email to all staff members and all students
Sampling	Sampling would consist of 209 users - 184 students and 25 staff
Ethical Issues	It would be determined whether there would be any ethical issues
Significance & Limitations	Organisational: This research is to look at whether there would be any impact on the UCO. Theoretical: By looking at the Technology and Usability Models, this research could both apply them to the project as well as look at how they have been used by other organisations.

Figure 14: Research Choices

3.5.1 Questionnaire Design, Administering and Sampling

Having decided that a feedback survey questionnaire was the method of sampling, the next step was to look as to the type of design needed; how it was going to be administered and decide what the sampling strategy would be. Primarily the structure and content of the questionnaire had to be user friendly. The next step was that in order to get an informed response, certain criteria had to be considered, i.e. questions should not be open ended; any alternative answers required should be short and to the point; consideration should be made as to whether single or multiple responses are required; if there would a need for "another" as an answer category in order to be able to illicit a response.

The directive for the respondent has to be straightforward and well defined (Appendix 4: Usability Questionnaires). There is then the assumption that the respondent gives

informed consent on return of the completed survey questionnaire (Cooper, D, R. Schindler, P, 2006) as the respondent has been given the reasons for the survey and how it will be conducted. Another criterion to consider was to make sure that the questions asked would not be biased in any way. Also the questions had to cover the topic being discussed and should be impartial. Finally there should be no deception by omitting any of the reasons for the survey and so a statement was made at the beginning of the questionnaire outlining in detail, what the survey, was about and the reasons behind it (Appendix 5: Virtual Desktop Questionnaire). As it was to be an anonymous response, it was hoped that the respondents would be more honest with their replies.

Together with these criteria, it was decided that the survey questionnaire would be designed, which would be able to give feedback on usability and technology acceptance. It was decided to ask the demographic questions at the beginning of the survey, even though it is reported that these should be asked towards the end (www.userfocus.co.uk), as many users may see them as too boring and be put off from completing the survey. As this research includes looking at the usability factors, the questionnaire chosen was the Computer System Usability Questionnaire (CSUQ), which was tailored for this survey. There are a variety of usability questionnaires available (Appendix 4: Usability Questionnaires), which can be freely downloaded via the internet. The questions set using tick boxes, were a combination of dichotomy (yes/no); multiple choice; and ones, which were measurable via the Likert scale (Robson, C, 2002). The answers for the Likert scale consisted of: Definitely Not starting as number 1 with Definitely at the other end of the scale at 5.

The next step of the design process is to look at its reliability. Reliability in this context means consistent (Oppenheim, A, N, 1992). Oppenheim (1992) suggests that fewer errors are made if the questions are consistent. Should there be a difference on two different occasions then there could be an indication of a change measurement or it could be genuine. Denscombe (2003), however, indicates that better data could be analysed if the questions set are similar. There are other theorists, however, who feel that reliability is difficult to determine, e.g. Hanson (1980) indicates that behaviour and attitude could be absent, but Mischler (1991) feels that differences between questions and answers can result in inconsistencies. Finally the researcher has to remember not to include too many

questions, so as to overwhelm the respondent and to remember to ask the pertinent questions (Czaja, R, Blair, J, 1998).

Administering the survey questionnaire was unsupervised and as previously stated one to one interviews could not be undertaken due to social factors. Once the questions had been set, the questionnaire was designed via the Google Drive on the internet, which has the ability to offer free templates and functions for survey questionnaire design. The reason for this choice is because most other on line survey companies require payment if more than 5-10 questions are set. Also it depends on how many questionnaires are needed and again it will depend on how much will need to be paid, e.g. SurveyMonkey, CheckBox, FluidSurveys, QuestionPro, KwikSurveys etc. Some of the questions asked were usability led, looking at efficiency; effectiveness; satisfaction and learnability. Others were technology acceptance led, i.e. perceived usefulness; ease of use; intention to use; attitude; usefulness; perceived cost; motivation; and self-efficacy. This was the more appropriate method of administering the questionnaire as other methods were not appropriate and time constraints indicated the internet method was the simplest and quickest method to use.

Different Methods of Administering Questionnaires available are (De Vaus, D, 2002):

- Paper & Pencil Interview
- Computer Assisted Personal Interview
- Computer Assisted Telephone Interview
- Computer Assisted Self Interview
- Disk by Mail Interview
- Plain Text in body of E-mail
- Questionnaire in body of an email or attachment in HTML (Hyper-text Mark-up Language)
- E-mail with executable questionnaire
- Web based HTML survey
- Dynamic Web Survey
- SurveyWriter (via internet)
- Response-o-matic (via internet)
- Internet-rogator (via internet)

- Instant Survey (via internet)

Selecting the sample of users was relatively easy, as the UCO is a small establishment. A decision was then made to send the questionnaire via a link in an email to all staff members and all students, no matter which course they were taken. This was a reasonable selection; however, it must be noted that even a small number as thirty samples can be valid (Saunders et al, 2000). The sample consisted of different age groups; ethnicity; and male/female; staff; and students. Using the questionnaire method, however, could produce a low response (Oppenheim, A, N, 1996). Cost, fortunately was not an issue, which benefited the researcher.

The survey questionnaire now devised was sent out to 209 computer users within the UCO. These 209 users consisted of 184 students and 25 staff (the UCO is a small establishment affiliated to the University of Huddersfield). The mix of users was both male and female and the age group varied between 17 and over 50 years old. The questions asked would be a mixture of technology acceptance and usability questions. They would enable the researcher to look at whether the users would accept or reject desktop virtualization within the UCO. These results would also determine if the introduction of new technology could enable the UCO to be an innovator within the higher education setting, by offering a more advanced way of learning.

3.6 Ethical Issues

Different professional organisations have their own code of ethics. One such code of ethics from the British Sociological Association (BSA) states:

> *"As far as possible participation in sociological research should be based on the freely given informed consent of those studied. This implies a responsibility on the sociologist to explain as fully as possible, and in terms meaningful to participants, what the research is about, who is undertaking and financing it, why it is being undertaken and how it is to be promoted."(BSA, 2002)*

Trust is essential in any endeavour requiring the co-operation of others. When conducting any survey, the researcher will have a duty of responsibility to the following groups of

people: the general public; any clients or sponsors; the profession currently working in; and respondents. As previously stated, respondents had already been made aware of the research via a covering email with the link to the questionnaire as well as informed consent, confidentiality and anonymity. However, honesty and trust are qualities that are earned and as the researcher was a member of staff at the UCO, i.e. working within the Computing and Library Services at the UCO for a number of years, it was felt that trust and honesty had already been earned from both staff and students for some time. Also gaining permission from the Principal again indicated that these qualities had been earned. (Verbal permission was granted to undertake this research at the UCO by both the Principal and Vice-Principal, who both took part in the survey).

Assurances need to be given also regarding use of the results. In this instance the results would be used if feasible to introduce a virtual desktop within the UCO to improve current methods of learning and teaching. Therefore, reciprocity indicates that the UCO would benefit. Also the researcher needs to consider if there is going to be a conflict of interest. In this particular instance there were none.

3.7 Significance and Limitations

3.7.1 Organisational

The significance of this research could have a great impact on the UCO. There would probably be cost implications if the findings indicated that a virtual environment was wanted or even needed to improve the quality of education for high education users. However, research results suggest that it is not always necessary to make any practical changes, where good practice is already taking place (Easterby-Smith et al, 2004). It might also be found that both the quantitative and qualitative processes are acceptable. There were no limitations foreseen with this research from the organisational aspect.

3.7.2 Theoretical

The topic could be looked at in great depth and supported by applying and examining the applicable theoretical models. By applying these models, the researcher should be able to

reach the outcomes required for this topic and so answer the research questions originally asked. This will then determine whether the research was valuable in its undertaking. The Technology Acceptance and Usability Models are the main focus towards achieving the result intended. The theoretical limitations surrounding the research is that although there is a vast amount of literature from all around the world, it is very time consuming sifting through to find those which are more relevant to this research. Application of these models to virtual reality seems to have taken off more quickly in America and the Far East compared to the United Kingdom.

3.8 Secondary Research

Secondary research also includes quantitative and qualitative data. This usually is used in both descriptive and explorative research via various media see Figure 15. As this type of research is desk bound, it focuses on academic literature and theoretical models associated with the research topic chosen. The gathering of information is sourced through different resources again as seen in Figure 15. The reasoning behind this is to look at what has been undertaken by others relating to this topic and to see what solutions have been realised already. In this way the researcher is able to assess their own work critically and justify it.

Therefore it is very important that any secondary data sources used should be evaluated. There are a number of criteria to consider as to whether the data gathered is overall suitable. Some of these are: does the information found, able the researcher to answer the research questions/objectives set; does the demographics of the research match the subject matter; is the information found up to date; can the variables required for the research be found within the information available. As well as the overall suitability of the data available, the researcher also needs to ensure how precise the data is; i.e. is the information found reliable enough? Is it credible? Is the source of the information reliable (e.g. does the author have the correct credentials for producing their work)? Is the information copyrighted? If sampling was used, were the correct methods applied and the results reliable?

Finally the researcher needs to be aware of any costs and benefits involved; i.e. what time and costs are needed for gathering the information required? Can the information be

downloaded to make analysis easier, by using a spread-sheet and/or a statistical analysis program? Please note however, that the information gathered for this particular research has been discussed in greater depth in Chapter 2: Literature Review.

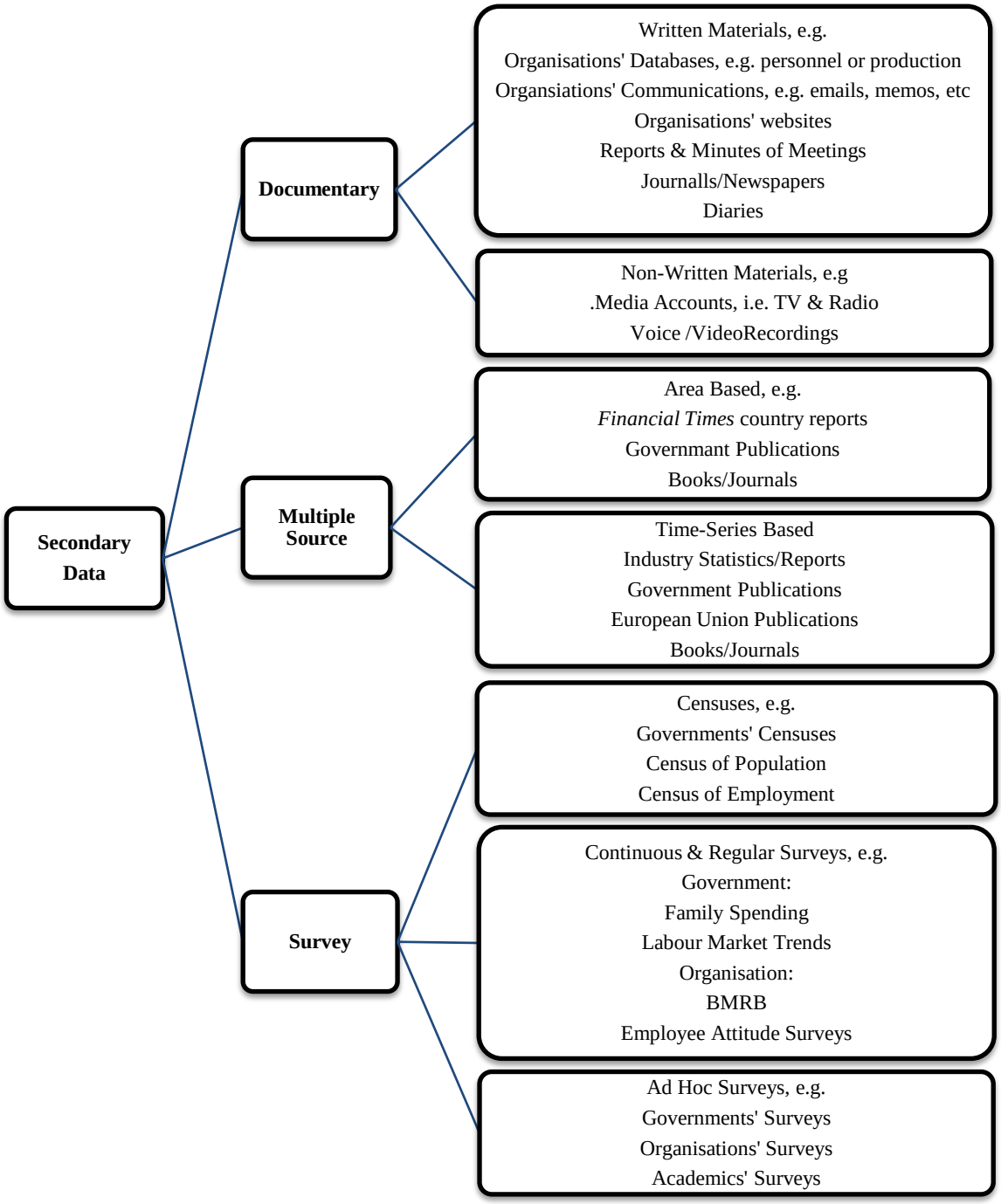


Figure 15: Types of Secondary Data (Adapted from Saunders et al, 2006)

3.9 Chapter Summary

Chapter 3 looked at the methodology of research and how it can be undertaken. This involved looking at the research onion model and how it can be used in research. The research plan and how it helps to look at the whole topic in depth. Also the research design was discussed looking at the different paradigms and how they can be applied to the topic. In this instance it was felt that the Positivistic paradigm was more applicable. Quantitative and Qualitative were both researched thoroughly and in view of their characteristics, a decision was made that both could be used in this research.

The survey questionnaire was defined using technology acceptance and usability questions by using a Likert ranking type scale for the answers. It was also discussed as to how this survey questionnaire was to be administered to all users at the UCO, i.e. students and staff via the campus' intranet. The ethical issues were discussed and in this case there were none. Also the significance and limitations were addressed. From an organisational perspective, it was determined that there were no limitations; however there could be benefits to the UCO from any positive outcomes. The theoretical significance indicated whether the models used would be value to this research and that there were theoretical limitations as a lot of research into the virtual reality world has mainly been outside of the United Kingdom (UK), but that there was probably enough in the UK surrounding the virtual desktop within a higher education setting.

Finally secondary data research was looked at. Although it has been discussed in greater depth within the literature review chapter, it was established that there was certain criteria the researcher needed to be aware of, to ensure that the data collected was reliable, valuable, precise and suitable for the research being undertaken.

Chapter 4: Research Findings and Analysis

As discussed in Chapter 3.5.1, it was decided that a survey questionnaire would be designed. It would then be aimed at all of the users at the UCO in order to obtain a good sample of gender, age and profile, i.e. whether student or staff.

The survey questionnaire was produced on line using Google Drive: https://docs.google.com/spreadsheet/viewform?formkey=dEVCUVFVT3VjOW5MQWNlUG1oa3FRd3c6MA#gid=0 (Appendix 5: Virtual Desktop Questionnaire

Once inputted it was sent to 209 computer users within the UCO (184 students and 25 staff). The mix of users was both male and female and the age group varied between 17 and over 50 years old (see Table 3 and Table 4). There was 100% return of this survey, which again is shown in Appendix 5: Virtual Desktop Questionnaire and Appendix 6: Virtual Desktop Survey (online answer)**.** In order to analyse these statistics, SPSS 20 (Statistical Package for the Social Sciences) program was used as this program enables the researcher to input all appropriate data, which is then analysed and produces statistics in both graph and table form.

The survey questionnaire was made up 37 questions. Numbers 1-15 are related to Technology Acceptance, whereas questions 16-37 are Usability related (see Appendix 5: Virtual Desktop Questionnaire).Both graphs and tables were used to show the results (Appendix 7: Virtual Desktop Survey (online graphs) and Appendix 8: Tables**).** From these 37 questions, 20 with graphs were selected for analysis as they give this research a clearer outline of the users' perceived intent to use the virtual desktop. The 20 questions selected were: 6; 8; 9; 10; 11; 14; 15; 18; 20; 22; 25; 26; 27; 30; 31; 32; 34; 35; 36 and 37.

		What is your age group?				Total
		17-20	21-29	30-39	40-49	
What is your gender (Student)?	Male	25	41	10	4	80
		31.2%	51.2%	12.5%	5.0%	100.0%
	Female	42	36	18	8	104
		40.4%	34.6%	17.3%	7.7%	100.0%
Total		67	77	28	12	184
		36.4%	41.8%	15.2%	6.5%	100.0%

Table 3: Age Group Variations of Students

		What is your age group?			Total
		30-39	40-49	Over 50	
What is your gender (Staff)?	Male	0	4	2	6
		0.0%	66.7%	33.3%	100.0%
	Female	4	5	10	19
		21.1%	26.3%	52.6%	100.0%
Total		4	9	12	25
		16.0%	36.0%	48.0%	100.0%

Table 4: Age Group Variations of Staff

4.1 Analysis of Selected Questions from Survey

Once all the data had been collected, it was decided that a sample of questions would be analysed in greater depth for this research. The reason behind this was due to the fact that these questions are more closely related to the virtual desktop itself and gives a clearer picture as to the users' perceptions, use and knowledge surrounding this topic.

Q6: Do you have access to the internet at home?

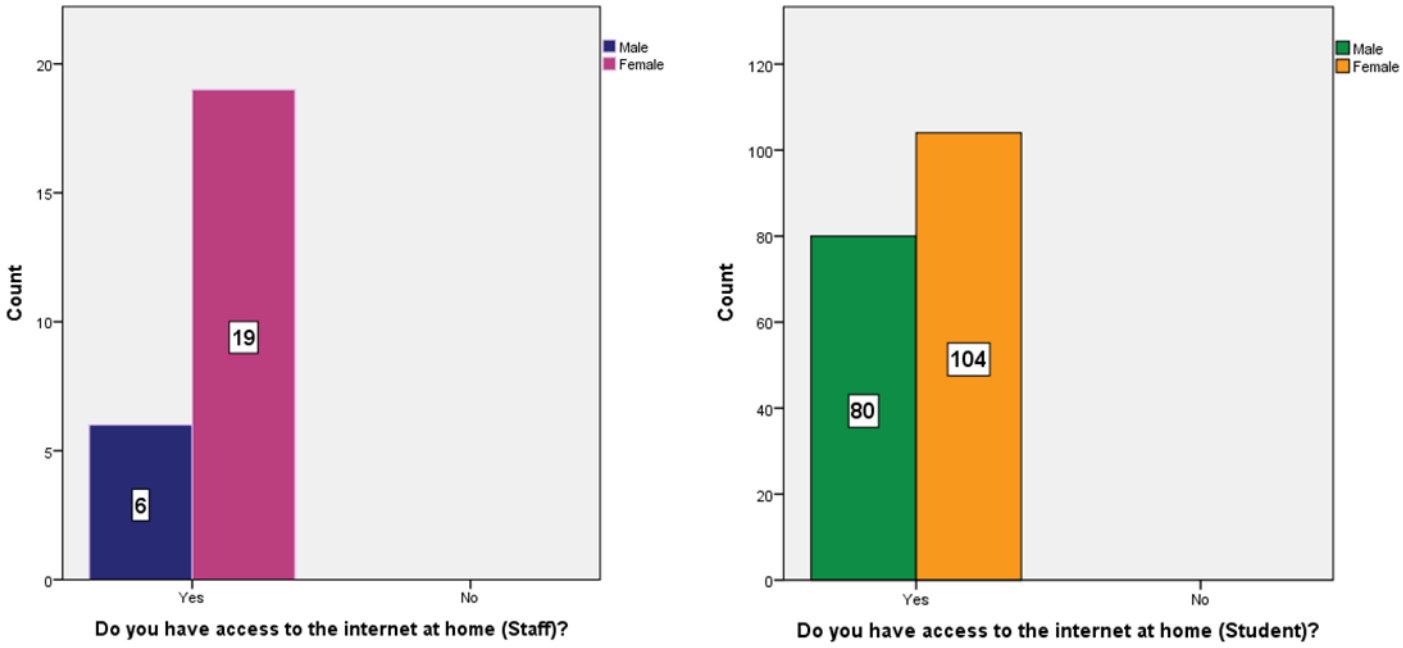


Figure 16: Home Internet Access

Figure 16**:** shows that all users questioned have access to the internet at home (Appendix 8: Table 5 & 6**).** This question was used as users would need access to the internet in order to access a virtual desktop.

Q8: What devices do you own / use?

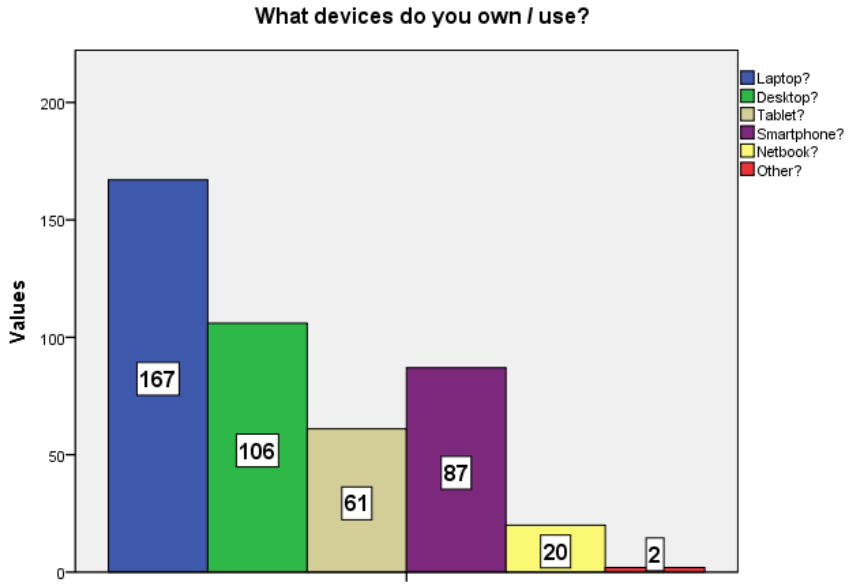


Figure 17: Computer Devices Currently Owned by All Users

Figure 17: shows that both laptops and desktops are the most popular device being used by all users at the UCO. What is interesting is that just under 50% of all users currently own a smartphone, which indicates this could be the future medium as they have increased in popularity since 2011 (Poulson, D, 2013) compared to computers that have been in use for well over 50 years. It has to be remembered here that any one user could own more than one computer device as the numbers totalled are higher than the 209 users. This answer will determine whether the computer devices owned would be able to support a virtual desktop (see Appendix 8 – Table 7).

Q9: What operating system do you use at home?

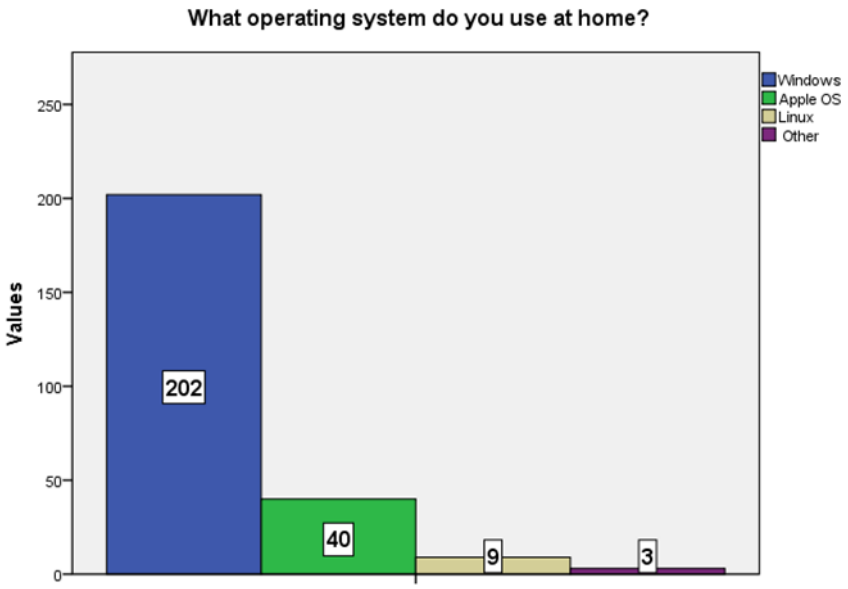


Figure 18: Type of Operating System Used

Figure 18: shows that 80% of all users (see Appendix 8 – Table 8) questioned use Microsoft Windows. This indicates that Windows is still the preferred operating system. Could this be due to the current cost of PCs compared to Apple Mac? This question also helps in deciding which popular operating system to trial the virtual desktop first.

Q10: Do you use your home computer for university course / preparation work?

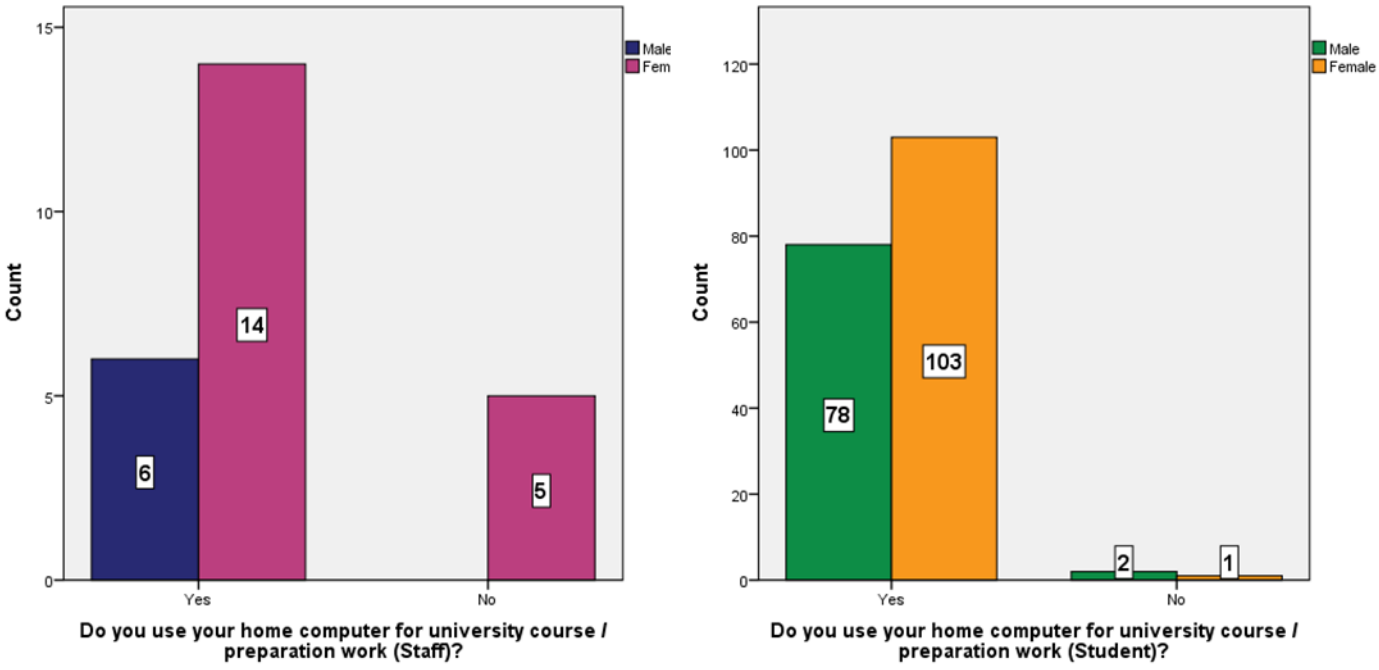


Figure 19: Use of Home Computer for UCO Work/Study

Figure 19: shows how many staff and students use their own home computer for course work or preparation work. 20% of female staff appear not to need to use their home computers; however although the responses were anonymous, it could be that these are non-teaching staff. What is interesting from these results is that 1.65% (3 from 184 students) does not do any course work at home and yet all declared that they have access to a home computer (see Appendix 8: Table 9 & 10)**.** This question shows whether it is likely that all users will use the virtual desktop from home.

Q11: How much time is spent on your home computer per week?

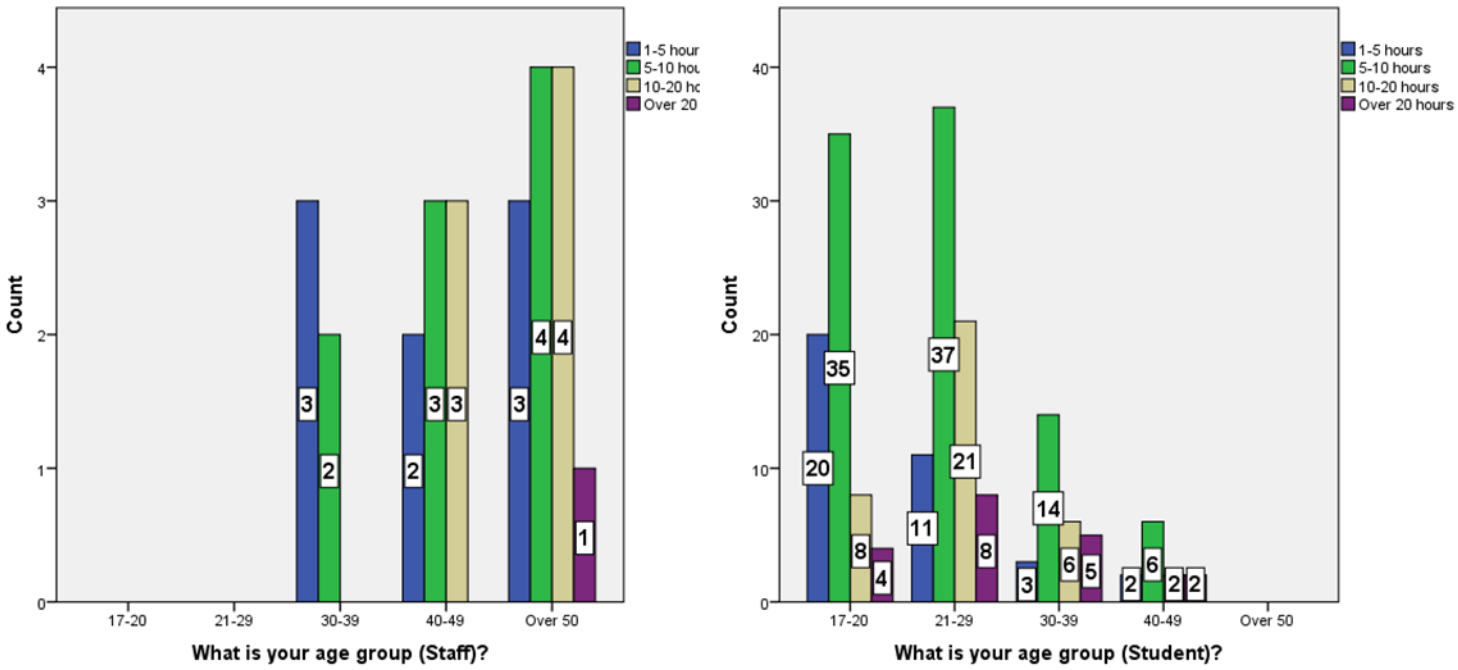


Figure 20: Time Spent On Course Work per Week on the Computer

Figure 20**:** shows how much time both staff and students use a computer on a weekly basis to undertake course work. This information shows that a lot of time is spent on course work and if programs were available via the virtual desktop, then time and money could be saved. Also it indicates that the 17-20 and 21-29 age groups of students are on average spending 5-10 hours per week on course work. However this is different for the staff group. There appears to be almost equal use of time on course work in all the staff age groups. These results also indicate that both staff and students spend time at home on course work (see Appendix 8: Table 11 & 12), which with a virtual desktop would allow them to work more from home. Whether staff would be allowed to work more from home is debatable. This question indicates how much time all users spend at home on their computers, which could indicate the possibility of more time being spent on a virtual desktop.

Q14: I have tried to use a virtual desktop before.

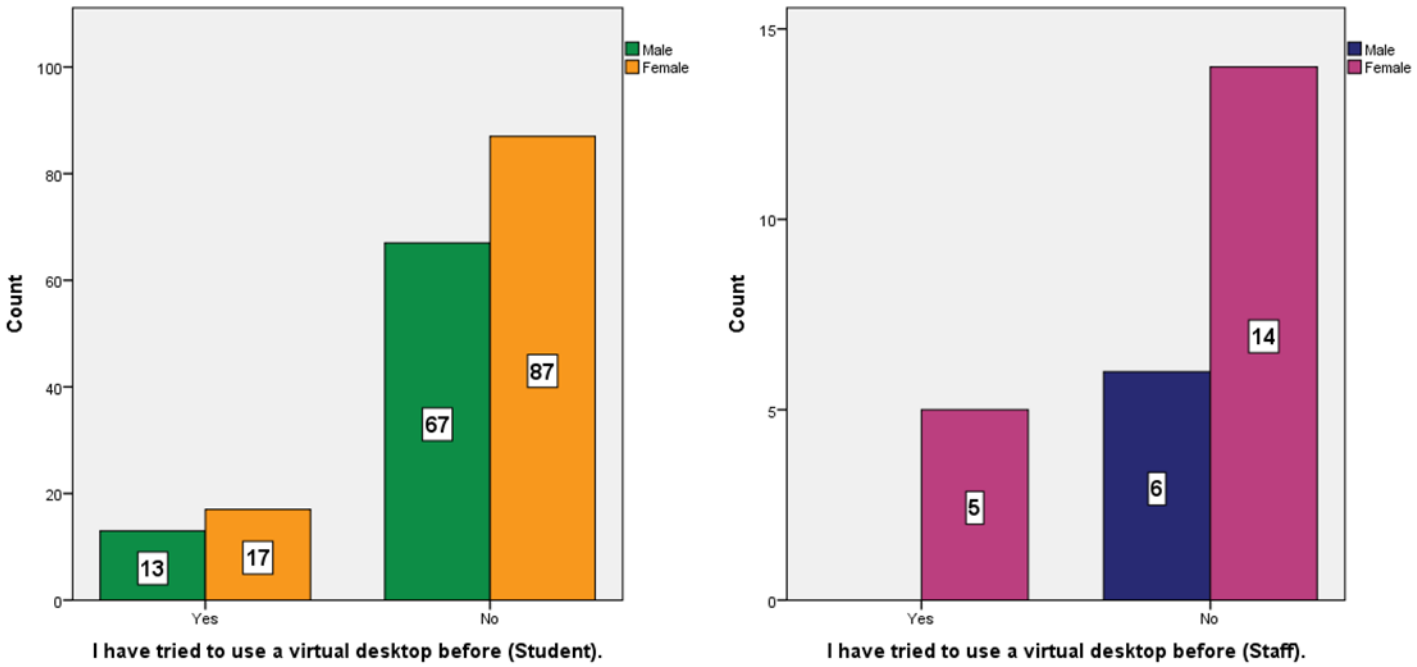


Figure 21: Previous Use of a Virtual Desktop

Figure 21**:** shows that 20% of staff has previously used a virtual desktop and all were female. However there appeared to be approximately equal numbers between the female and male students (16%), who had previously used a virtual desktop. This was interesting as the opposite was expected. It was perceived that males are more likely to embrace new technology quicker than females. Katz et al (2007) undertook research into male-female negotiations regarding computers. The results showed that males were more co-operative than the females as they were able to see the profitability for themselves; whereas the females were more social and were not self-orientated.

These results were helpful in identifying previous use of virtualization and how much training is likely to be needed for both staff and students (see Appendix 8: Table 13 & 14).

Q15: Would you like to be able to use the UCO programs from home?

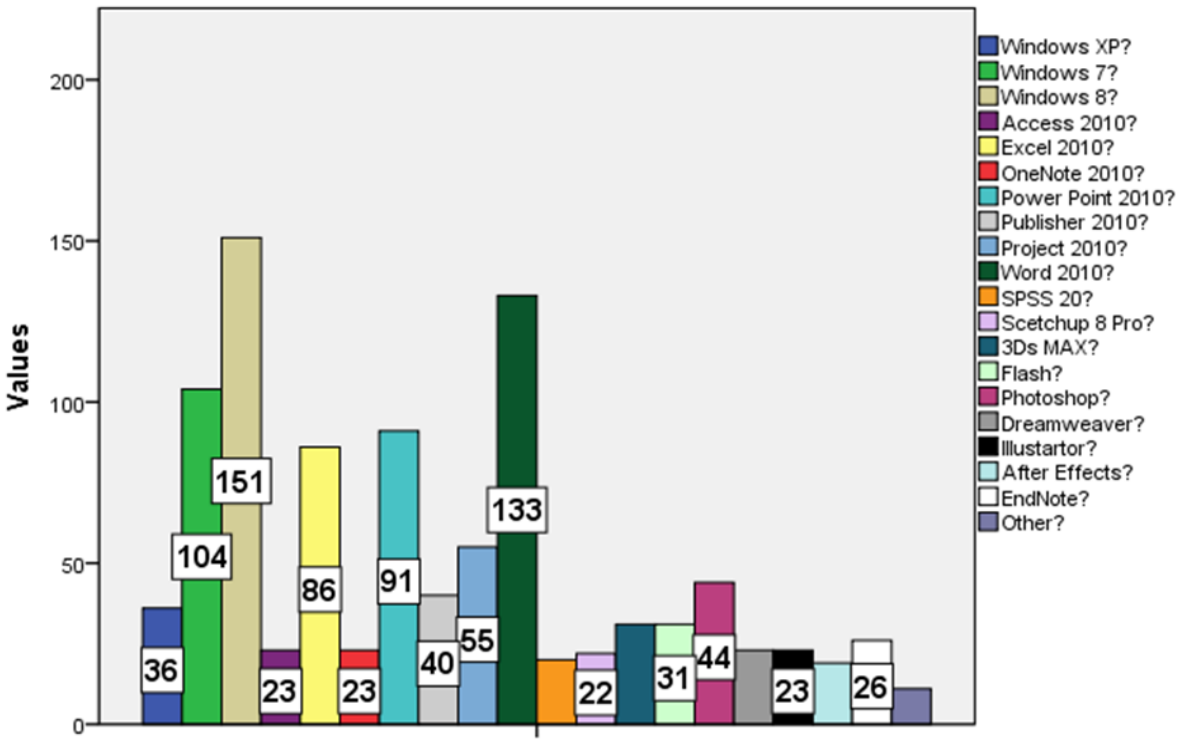


Figure 22: Most Popular Programs of Choice by All Users

Figure 22**:** shows the current programs available at the UCO and which could be made available via a virtual desktop depending on licenses and cost. As can be seen in Appendix8, most of these programs including operating systems are very expensive to buy and virtualization could be a way of making significant savings to the user. Table 15 (Appendix 8) shows the number of users, who would like use of these programs. This result is a very good indicator of the types of programs, which could be trialled first for usage.

Q18: I enjoy the challenge of new technology.

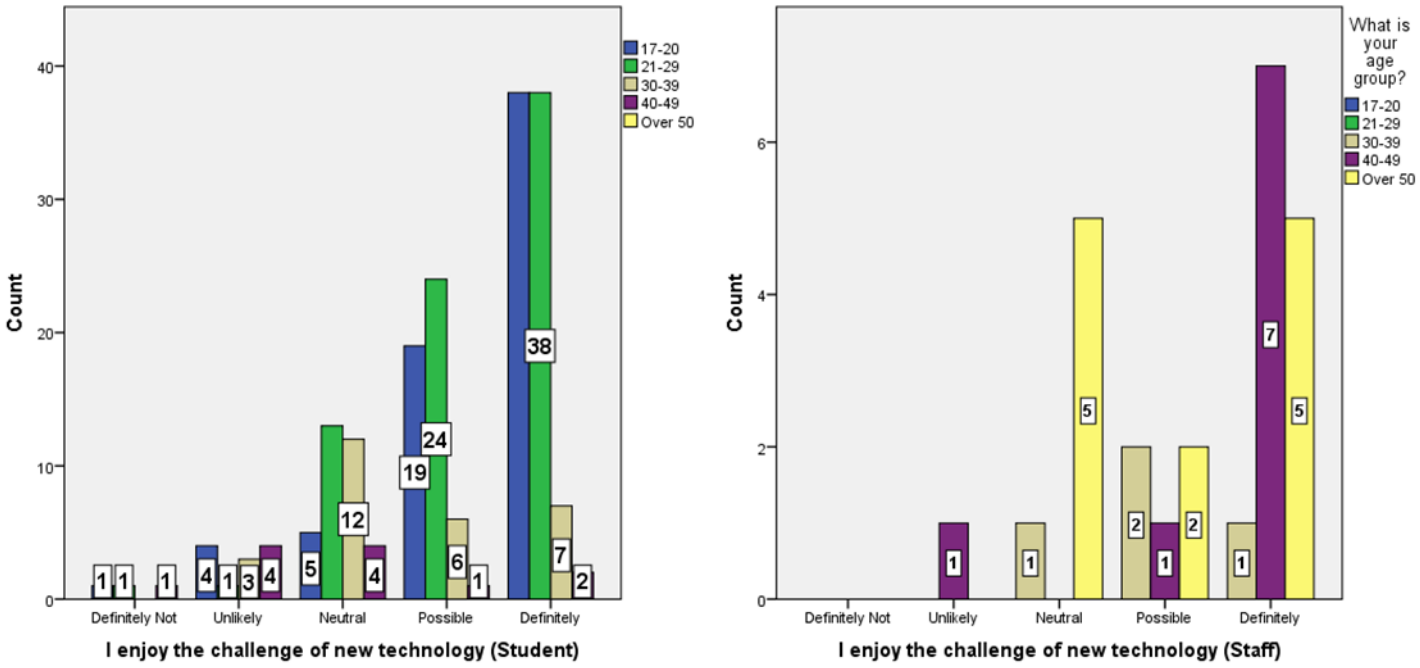


Figure 23: Challenge of New Technology for Students / Staff

Figure 23**:** shows which age groups of students embrace new technology better than others. As can be seen by the younger age groups, i.e. 17-20 and 21-29, they definitely enjoy the challenge of new technology. Could this be due to the fact that as one gets older, it is harder to retain knowledge and enthusiasm wanes? Rabbitt et al (1997) state that as one ages the brain and the central nervous system change also regarding its mental capacity. There have been studies done that show that there is a continuous and accelerating decline in cognitive performance in old age (Rabbitt et al, 1997).

The mature student may also not have the inclination to be enthusiastic about new technology as the younger age groups, due to possible family commitments; employment; life experiences; and other events in their lives. Table 16 (Appendix 8) shows that approximately 8% of students may have problems or are disinterested in new technology and that approximately 18% would not commit either way. This is an area that could be

developed more with students as to why there is a lack of interest in new technology as innovative change is an on-going change process.

As the staff age group is in the older ranges, it is difficult to make a comparison; however these results show that 72% of staff (see Appendix 8 – Table 17) enjoys new challenges, which in a way contradicts the results of the mature students. A reason for this could be that staff may not have as many external commitments, such as external course work etc.

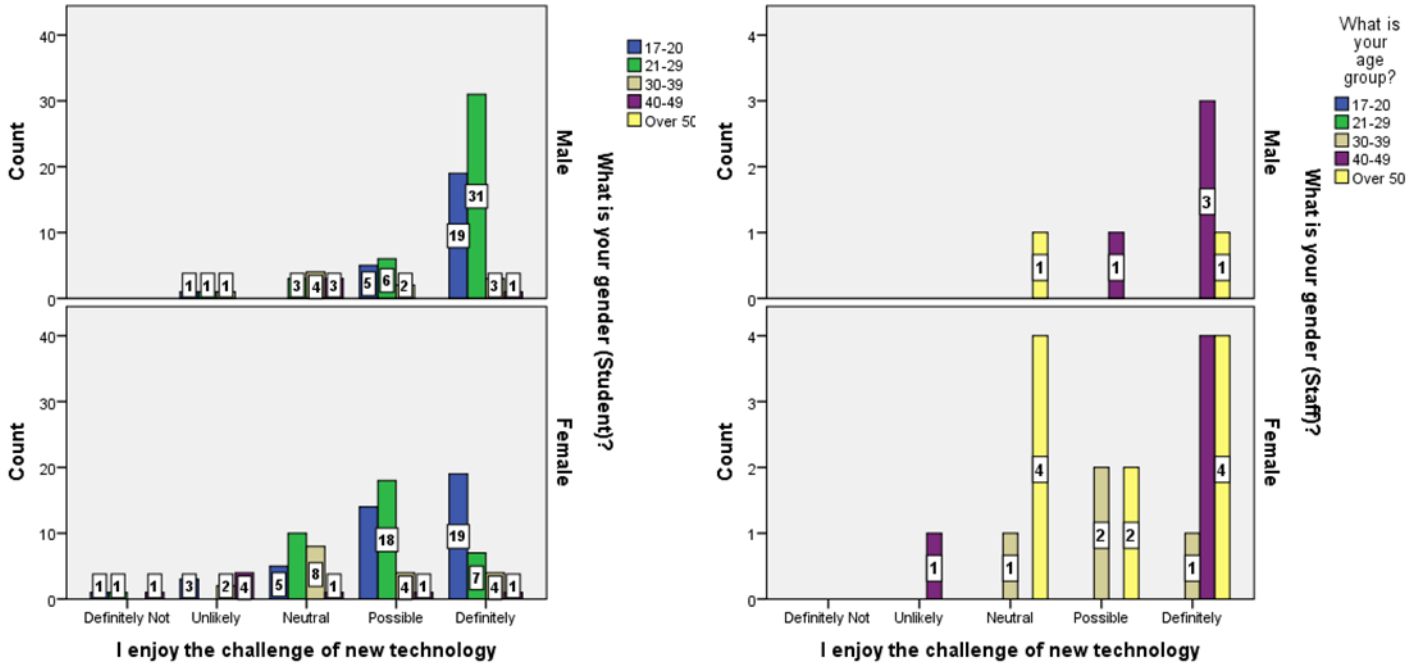


Figure 24: Challenge of New Technology between Male and Female Students / Staff

Figure 24: shows how the challenge of new technology is accepted by male and female students separately within their age groups. As can be seen above, the younger age groups, i.e. 17-20 & 21-29 of male students (76%) appear to be definitely interested in the challenge of new technology, whereas the female students still seem to have reservations as 41% of the same age groups state they would possibly enjoy the challenge (see Appendix 8 – Table 18 & 19).

The staff results show that 69% of females and 73% of males enjoy a new challenge (see Appendix 8: Table 20 & 21). This could indicate as previously stated that males are more receptive to new technology than females.

Q20: It sounds like a virtual desktop would be too complicated for me to understand.

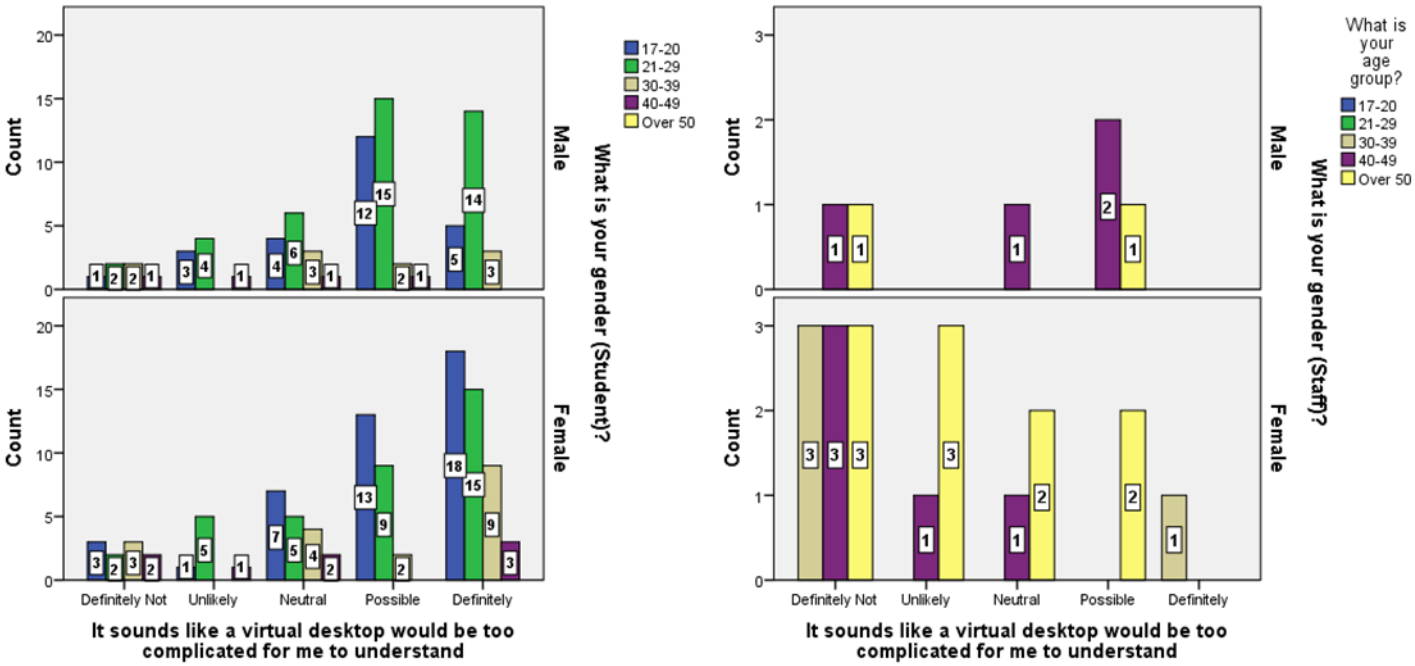


Figure 25: Is a Virtual Desktop Too Complicated for Students / Staff to Understand?

Figure 25: shows how both male and female students feel about using a virtual desktop. It would appear that the 21-29 age groups for male students (34% male) would find the virtual desktop too complicated, whereas the younger age group: 17-20 year old of male students is not as high (20% male), as they previously stated that they enjoy the challenge of new technology better. However it appears that the numbers of female students in both the younger age groups, i.e. 17-20 (43% female) & 21-29 (42% female) definitely would find a problem with a virtual desktop (see Appendix 8: Table 22 & 23).

As can be seen from the graph above, there appears to be a positive response from the female staff with 69% stating that they would not find the virtual desktop too complicated. The response from the male staff is equal either way between positive to negative responses (Appendix 8: Table 24 & 25). These results show how much training might be required from the IT staff as well as preparation work.

Q22: I need help from others when new technology is implemented.

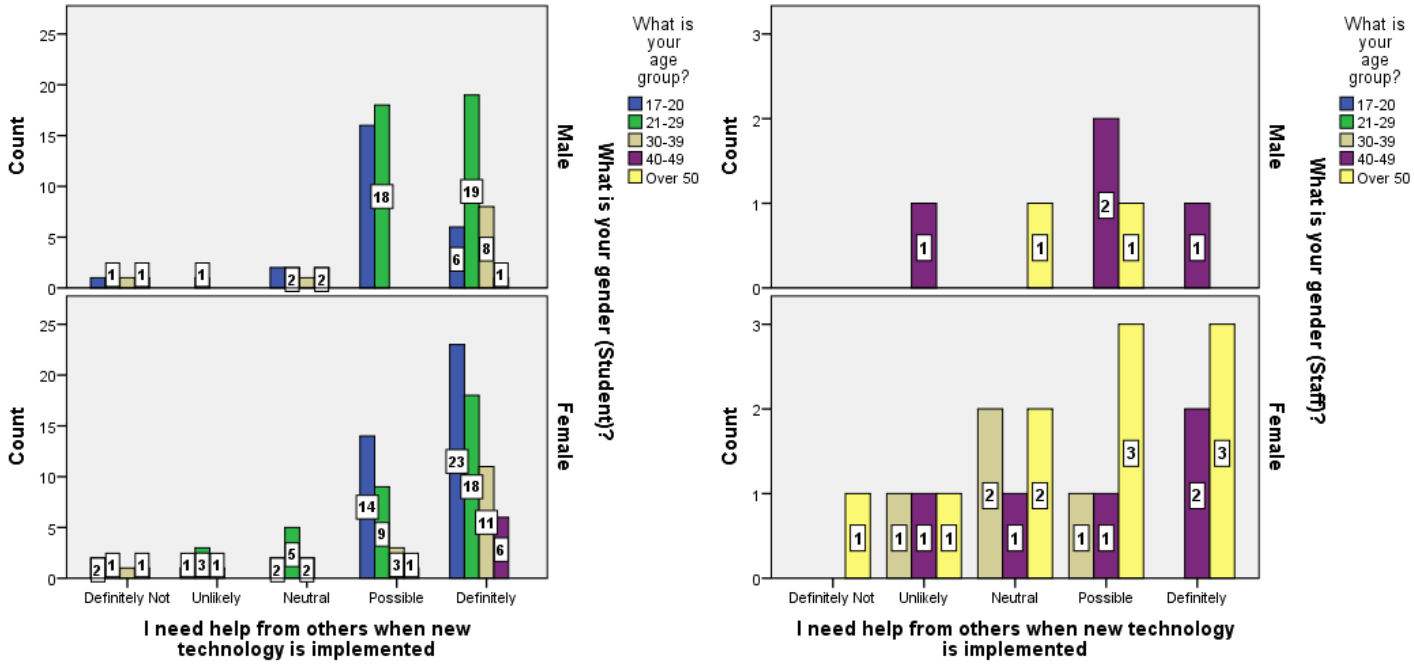


Figure 26: Help Required for Students / Staff on Implementation of New Technology

Figure 26: shows who require the most assistance when new technology is implemented as defined by both sex and age group. The outcome here is similar to the results from Q20 (see Appendix 5: Virtual Desktop Questionnaire**)**. The male students in the 17-20 age groups (24%) and 21-29 age groups (46%) would all need help with new technology. Again this is interesting as previously the younger male age groups all embraced new technology. This may indicate either they are eager to learn new technology or they may have a problem. When looking at the female student results, it can be seen that there is a higher number in the 17-20 year olds compared with the male students (55%) and the 21-29 year olds (50%). It again appears that there is a great difference between male and female students and their acceptance of new technology (see Appendix 8: Table 26 & 27).

These results show that 79 % of female and 83% of male staff also will require help when new technology is implemented (Appendix 8: Table 28 & 29). Again this indicates a great training requirement for all users.

Q25: I am concerned that a virtual desktop would not be very secure and others would be able to see what I am doing.

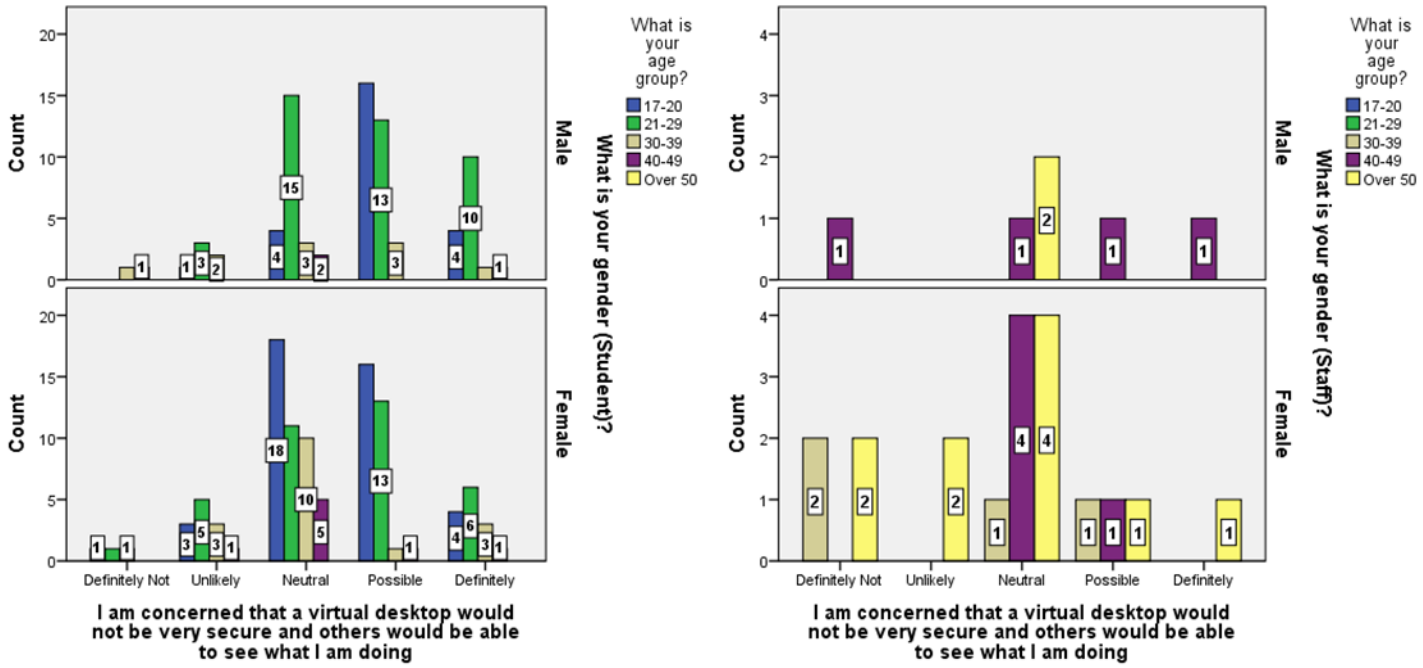


Figure 27: Security of the Students' / Staff Virtual Desktop

Figure 27: shows how both male and female students are concerned about how secure the virtual desktop would be. It appears that many students would be unsure about the security of a virtual desktop as it was shown in Q14 (see Appendix 5: Virtual Desktop Questionnaire) that only 16% of all students had previously used a virtual desktop. This could account for the high numbers given for the Neutral and Possible categories. Male Neutral – 24 (30% of all age groups); Male Possible – 32 (40% of all age groups); Female Neutral – 44 (42% of all age groups); and Female Possible – 31 (30% of all age groups – see Appendix 8: Table 30 & 31).

It appears from these results that 97% of all staff are unsure about how secure the virtual desktop (see Appendix 8: Table 32 & 33). As previous results (Q14) show that not many have used a virtual desktop previously, it could indicate the reason as to their concerns regarding security. This also shows that a great deal of assurance will need to be given via training, help guides etc.

Q26: Using a virtual desktop would help me better with my university work due to the easy access to the programs I need.

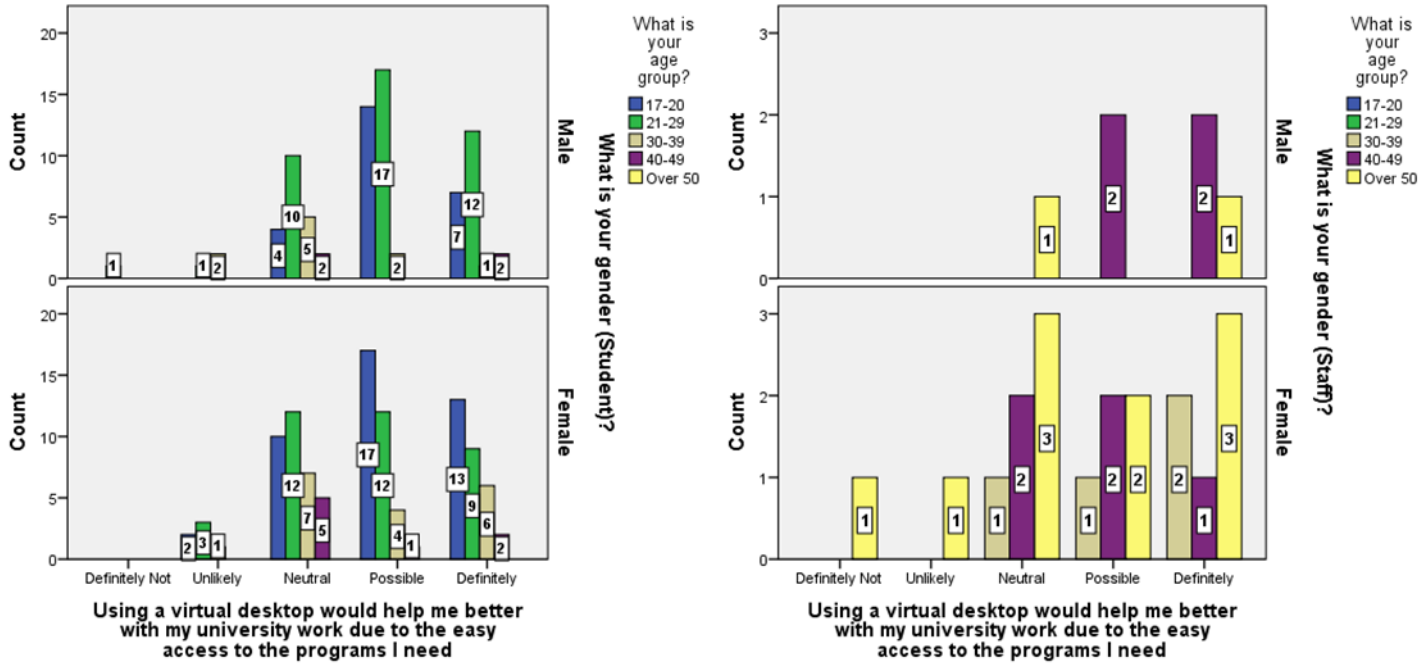


Figure 28: Students'/ Staffs' Easy Access to Programs Using a Virtual Desktop

Figure 28: shows how both male and female students would feel about easier access to the UCO programs via a virtual desktop. These results show that although there are a great number of students who would prefer easier access to their preferred programs via the virtual desktop, it also shows that there are a number who are undecided (neutral); i.e. 21 male students (26% of all age groups) and 34 female students (33% of all age groups). This again could be an indicator of previous non-use of a virtual desktop and its unfamiliarity (see Appendix 8: Table 34 & 35).

As staff are more likely to access programs for work purposes rather than course work, it could be probable that academic staff would find the use of a virtual desktop more acceptable than non-academic staff as they would probably need access to a greater number of specialized programs. As this research has not defined how many are academic and non-academic staff, it shows that the majority of staff have given a positive response, i.e. 58% females and 83% of males (see Appendix 8: Table 36 & 37).

Q27: Using a virtual desktop would allow me more time to do my university work as I could spend more time at home.

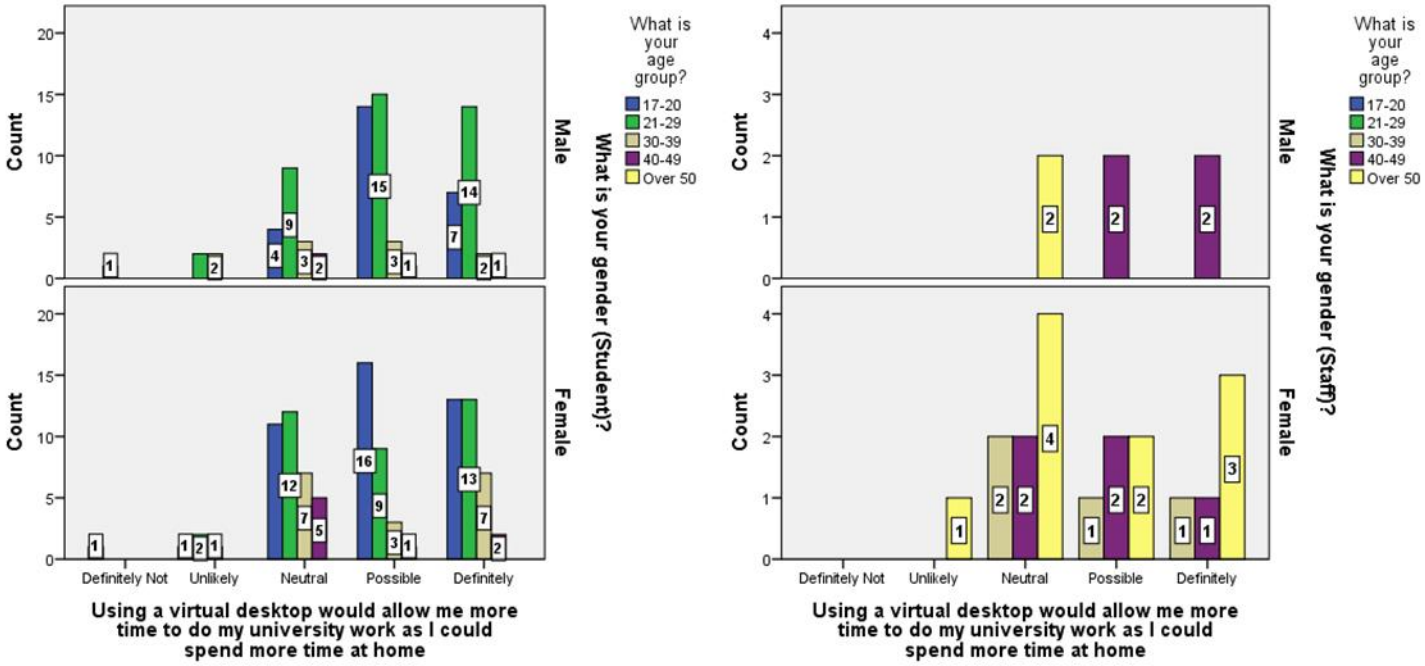


Figure 29: Students / Staff Having Extra Time At Home Using a Virtual Desktop

Figure 29: shows how students would like to spend more time at home doing their course work via a virtual desktop. Here again the results show as previously (Q14) a high number of neutral responses due to never using a virtual desktop previously, i.e. 18 male students (23% of all age groups) and 35 female students (34% of all age groups). However looking at the younger age groups, it appears that 14 male from the 21-29 group (34%) would definitely prefer to work from home compared to 7 of the 17-20 year olds (28%); and the female results show that there is an equal number of 13 for both the younger age groups: 17-20 year olds and the 21-29 year olds (33%). What could seem to be surprising was that there was a higher number in the older female age group compared to the males who definitely would prefer to work from home more? This relates to 9 female mature students from the 30-39 & 40-49 age groups (35%) compared to 3 from the same age ranges (21%) – (see Appendix 8: Table 38 & 39). The staff results, i.e. 67% male and 53% female staff (Appendix 8: Table 40 & 41), could indicate that it is the academic staff, who would like to be able to work more from home via the virtual desktop as it allows more time to

prepare course work; however the non-academic staff may only use their computers at home for leisure activities only. These results are an indicator of whether a virtual desktop would be used from home by all users.

Q30: A virtual desktop would reduce costs for me as I could work better from home.

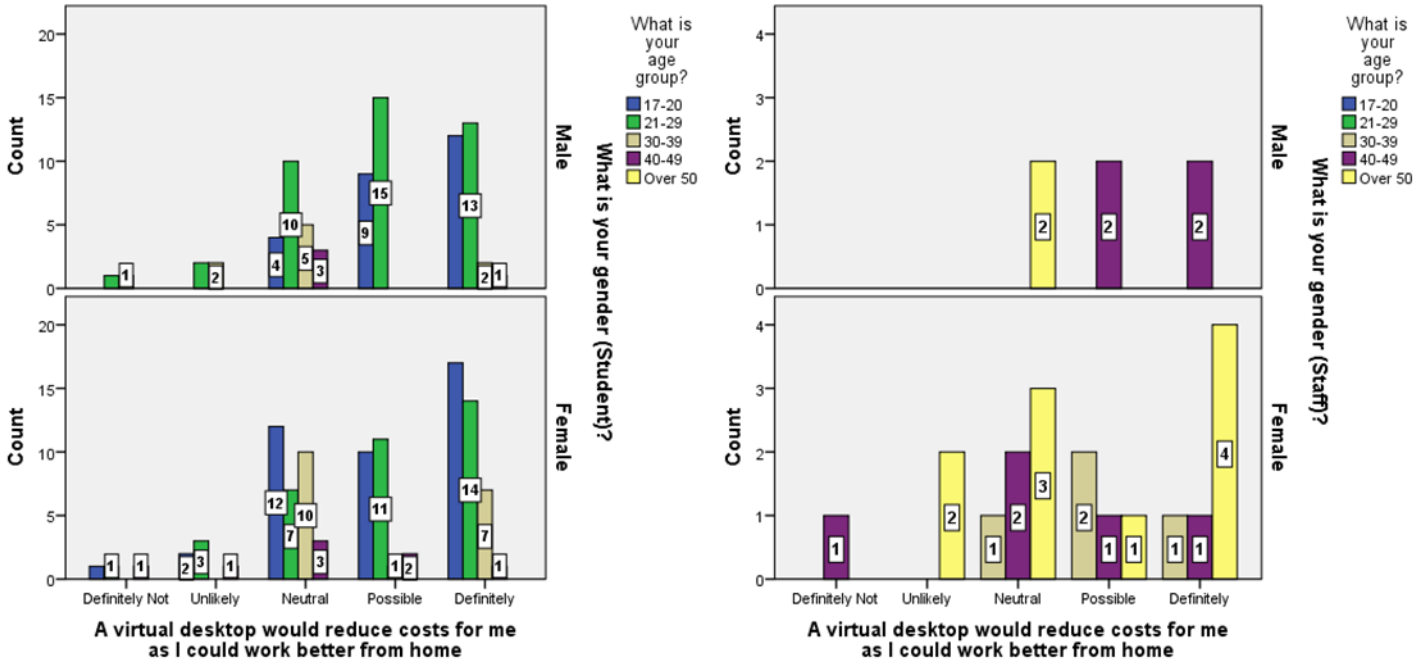


Figure 30: Reducing Costs for Students and Staff by Working from Home

Figure 30: shows how students and staff would prefer to save money by working more from home via the virtual desktop. The student results show that there are similarities in numbers between both male and females in the younger age groups, i.e. 17-20 & 21-29 year olds. However there still seems to be quite a few of undecided students (neutral category), especially in the older age groups, i.e. 21 of the 30-39 & 40-49 year olds combined (53%). The 53% includes both male and females, which again could be due to their unknown knowledge of the benefits of a virtual desktop (see Appendix 8: Table 42 & 43).

These results also show a higher percentage of neutral results amongst staff, i.e. 32% of female and 33% of male staff (see Appendix 8: Table 44 & 45). This again could indicate it is due to previous non-use of a virtual desktop. As a virtual desktop could be of benefit, it appears that all users are clearly unsure about it.

Q31: I could save money by using the UCO programs via the virtual desktop rather than buying my own copy.

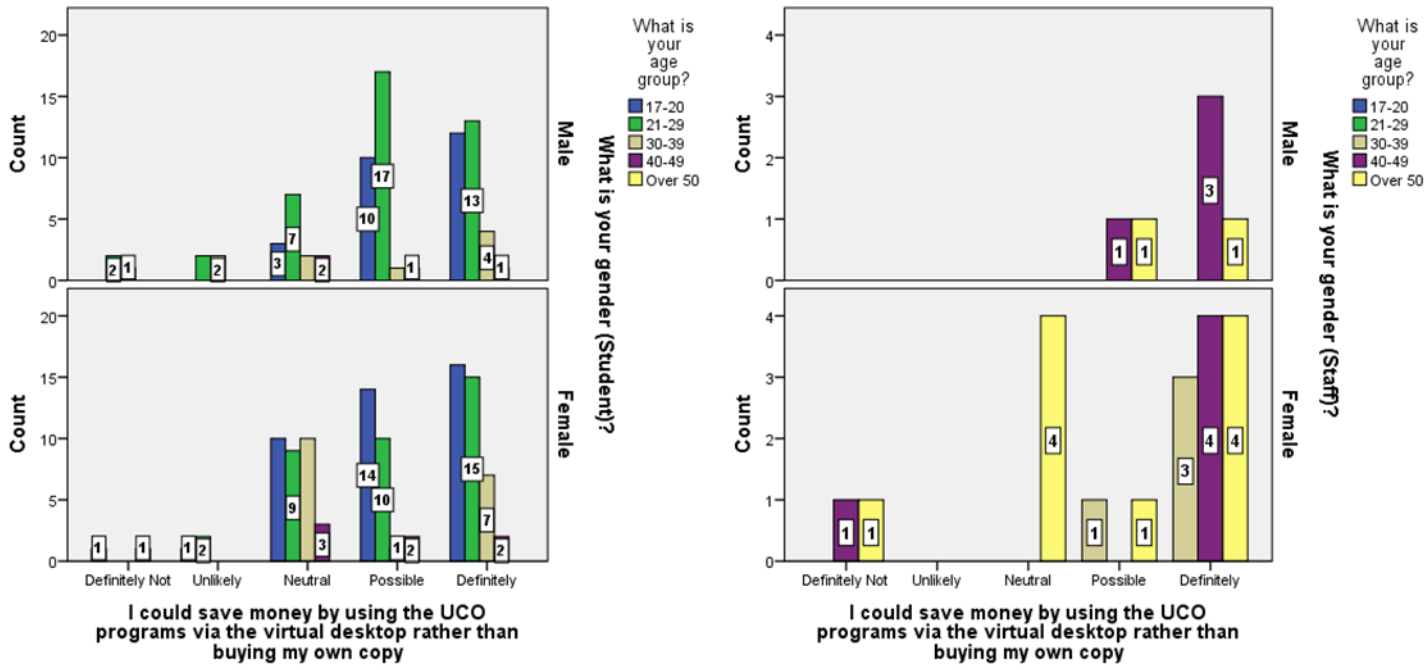


Figure 31: Benefits of Virtual Programs Compared to Own Copy

Figure 31: shows how students and staff feel about the cost savings when using UCO programs via a virtual desktop. Again the student results show that the majority of male and female students in the 17-20 & 21-29 year old age groups feel that they would definitely save money. There are 25 from these two male age groups (38%) and 31 from the two female age groups (40%). However there is still only a small number in the older age groups, i.e. 30-39 & 40-49, who definitely feel as though they could benefit. This again could be an indicator that having never used a virtual desktop previously, they would not know the actual benefits they could gain. As can be seen from the neutral category there are 4 male students from the 30-39 & 40-49 age groups (29%) and 13 female students from these same age groups (36%), who remain undecided (see Appendix 8: Table 46 & 47).

Here it appears that the majority of both male and female staff feel as though they would benefit by reducing costs with a virtual desktop rather than purchasing their own software programs, i.e. 68% female and 100% male staff (Appendix 8: Table 48 & 49). But again the question is: Would it be the academic staff, who would reap the benefits or the organisation?

Q32: I could save money by using the virtual desktop as my computer wouldn't need to be upgraded.

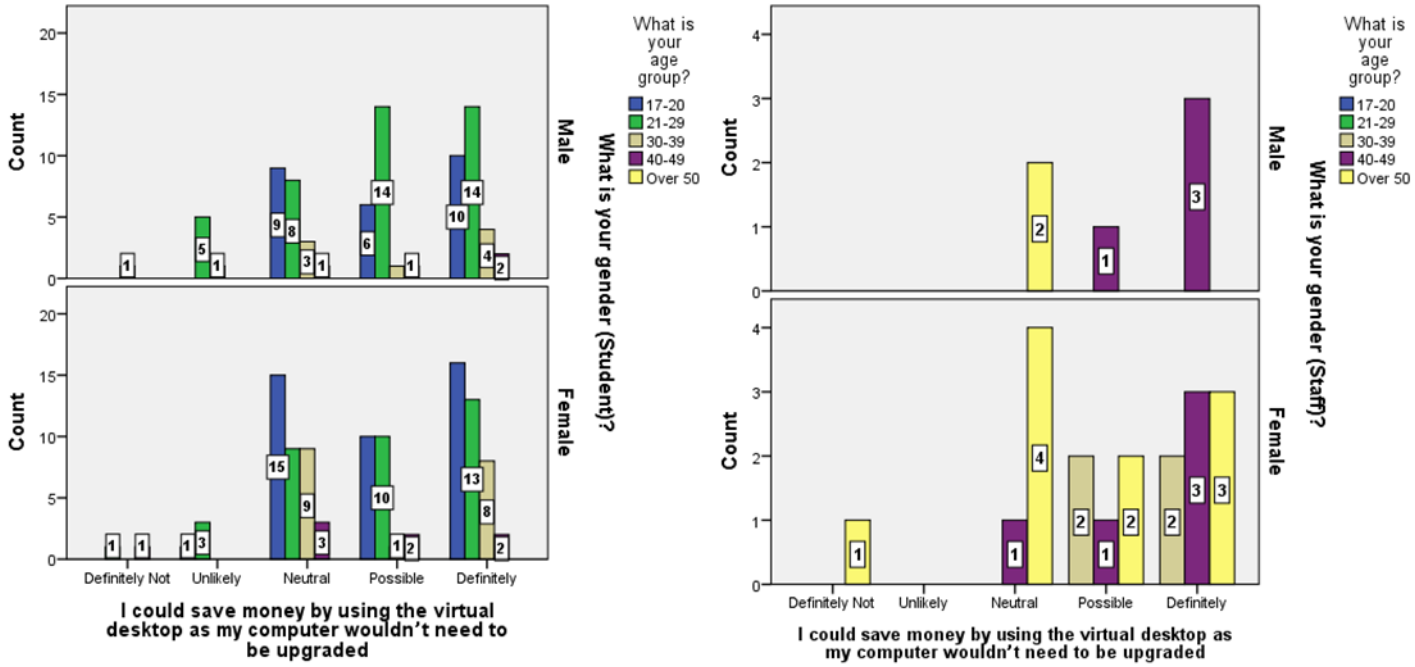


Figure 32: Benefits of not having to Upgrade Own Computer by Using a Virtual Desktop

Figure 32: shows whether students feel as though they would benefit by saving money by not having to upgrade their own home computers. The results here show that many students of all ages have not previously used a virtual desktop, as they have answered neutral to this question. This could also indicate a user's lack of knowledge about how to upgrade their computers, without thinking about virtualization also. The responses to neutral also show that 8 male (19%) and 9 female (25%) of the 21-29 age group are very similar in numbers. Within the younger 17-20 age group, the results show 9 male (36%) and 15 female (36%); however the older age groups, i.e. 30-39 & 40-49 show 4 males (14%) and 12 females (46%). This shows a greater number who would probably need more help with the virtual desktop whether there is a need or not need to upgrade their own home computers (see Appendix 8: Table 50 & 51).

The staff results appear similar to the students' as there is a higher percentage, who feels that they would benefit by not having to upgrade their computers. It shows 68% of female

and 67% of male staff, who believe that they could reduce their costs (Appendix 8: Table 52 & 53). These results help the researcher identify again the need for training.

Q34: I would like to be able to print from my own technology devices at the UCO.

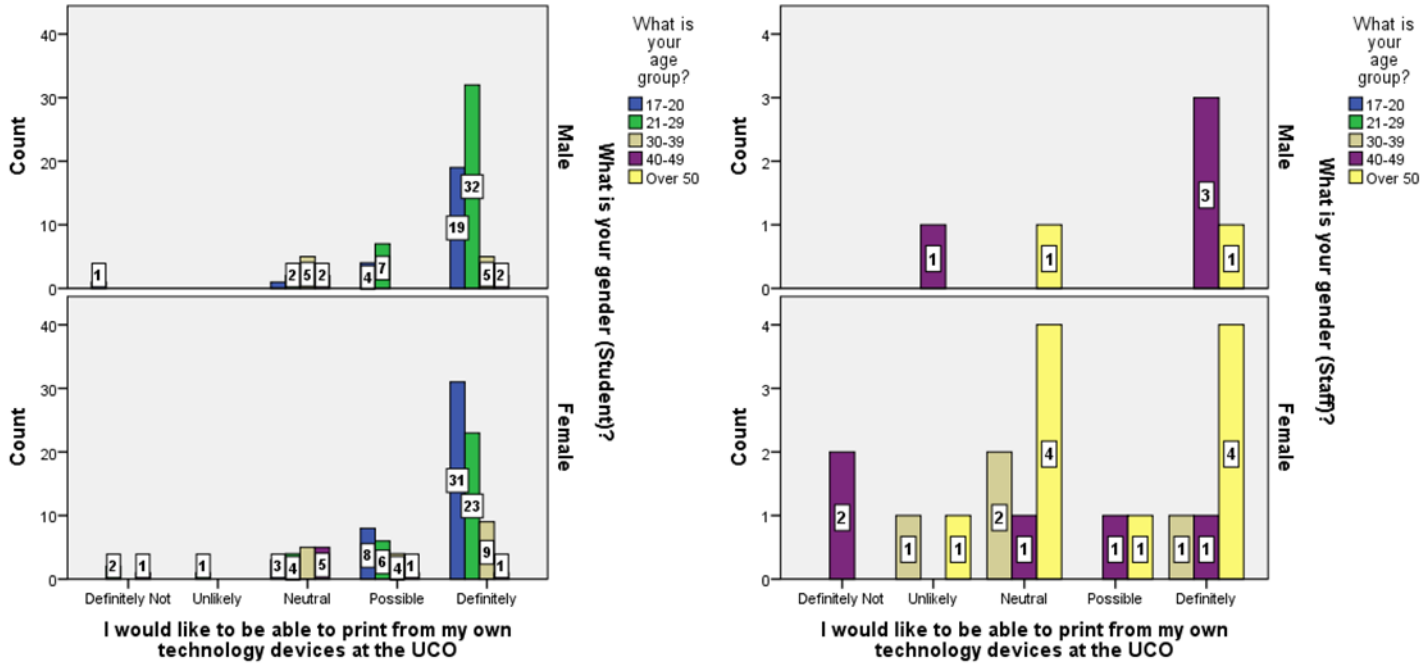


Figure 33: Ability to Print from Own Devices at the UCO via Virtualization

Figure 33: shows whether students would like to be able to print any of their course work via the virtual desktop to the UCO printers. These results show that the majority of students would definitely like to be able to undertake this task. It shows that there is more interest from the 21-29 male age groups (78%) and the 17-20 year female age group (74%); however there are only 9 female and 5 male mature students (50%) from the 30-39 age groups. This indicates that the younger age groups would prefer this option (see Appendix 8 –Table 54 & 55).

There is less of a positive response from female staff as there are 21%, who gave a negative response, 37% a neutral response and 42%, who gave a positive response. However male staff gave an 83% positive response (Appendix 8: Table 56 & 57). These answers tell the researcher that users would like to use external devices via the virtual desktop.

Q35: I would not need to worry about the UCO being closed during the holidays as I can still work from home.

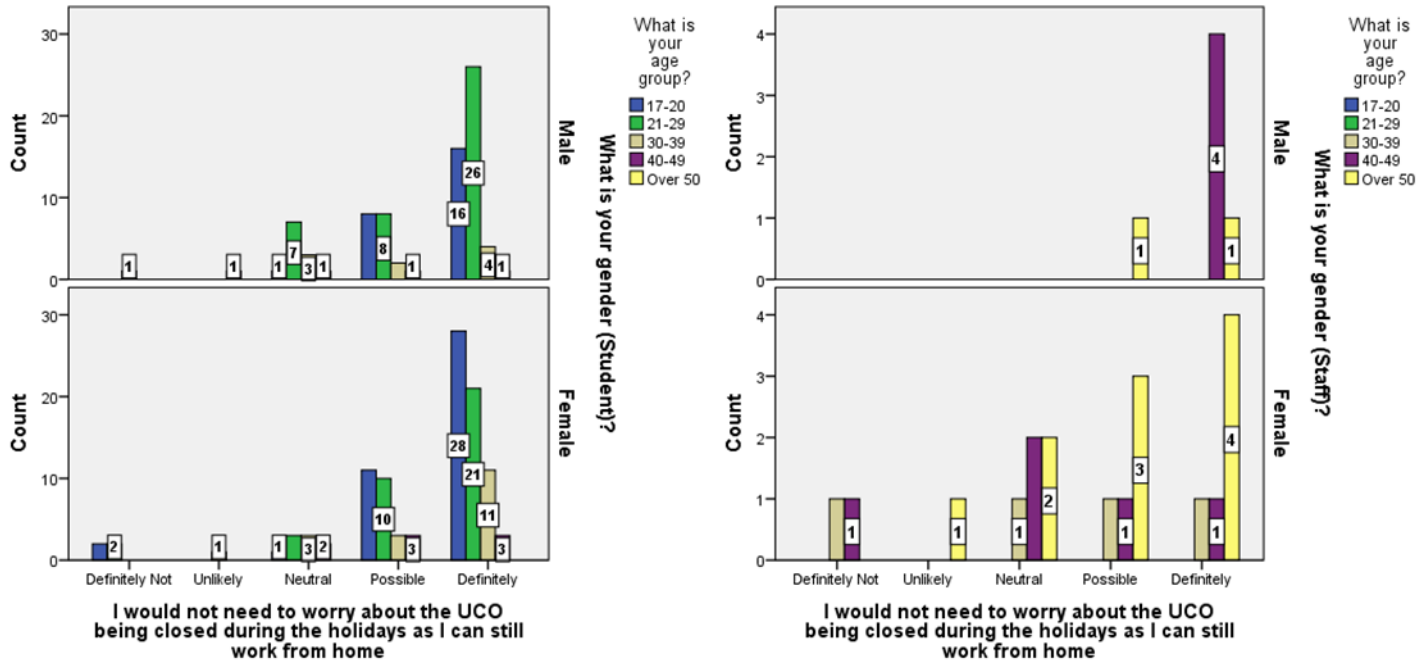


Figure 34: Ability to Work from Home when the UCO is closed

Figure 34: shows that the majority of students would like to be able to work from home and access the UCO programs even when the UCO is closed for whatever reason, e.g. bank holidays; Christmas & Easter periods; extreme weather conditions etc. This would allow them not to break off from their course and to carry on studying from home. These results show 47 male students from all age groups (59%) and 63 female students from all age groups (61%), would definitely like to access the UCO even when it is closed. The other categories show: Possible – male (all age groups – 19) 24%; female (all age groups – 27) 26%; Neutral – male (all age groups – 12) 15%; female (all age groups – 9) 9%. Therefore the total number of students, who would prefer to access the UCO during the holidays, is: male (all age groups – 66) 83% and female (all age groups – 90) 87%. This is the outcome of combining both possible and definitely categories (see Appendix 8: Table 58 & 59).

The staff results show that male staff would like access when the UCO is closed; however it appears quite the opposite for female staff. 100% of the male staff would access via virtual desktop when the UCO is closed compared to 58% of female staff (see Appendix 8: Table 60 & 61). Therefore there is still 42% of female staff, who would not want access. Again the reason could be that these 42% might consist of non-academic staff, who would not require access to the UCO when it was closed.

Q36: It would help me greatly being able to access the UCO programs from abroad.

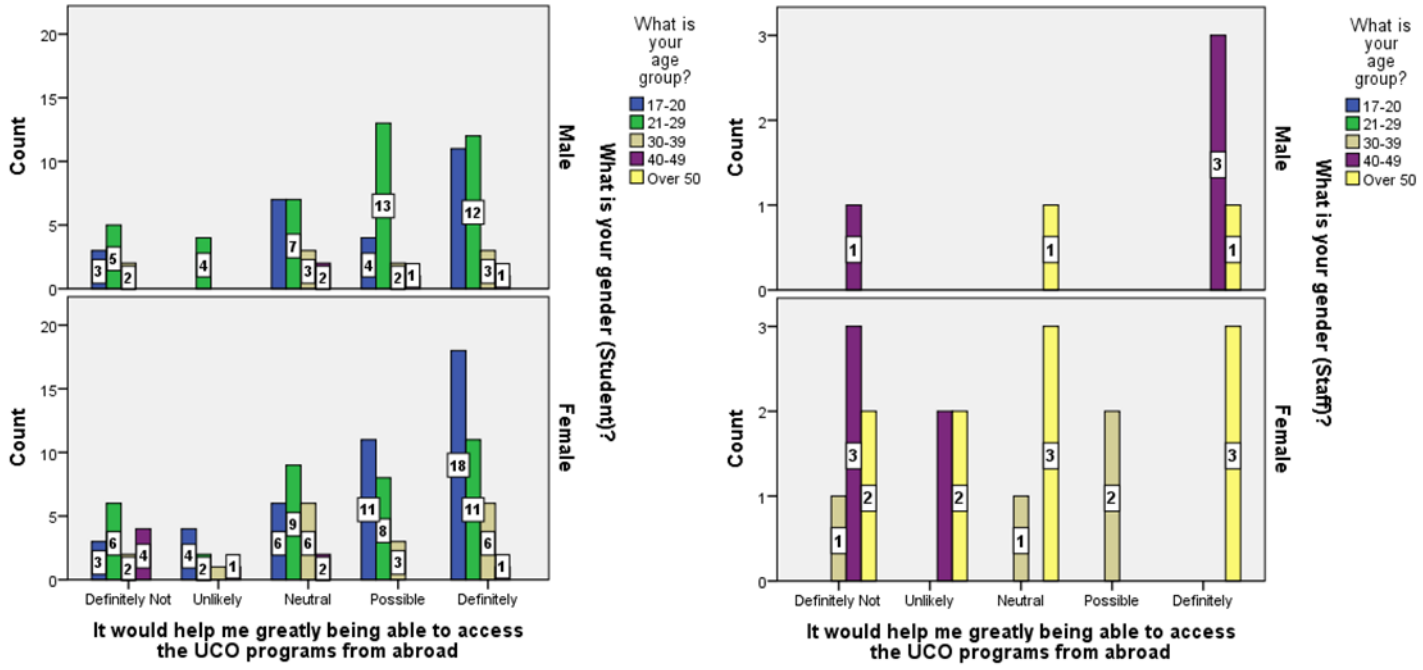


Figure 35: Ability for Students to Access UCO Programs from Abroad

Figure 35: shows whether students would like to be able to access the UCO programs from abroad. This could be of benefit to those students, who go away on holiday or for overseas students. Currently at the UCO there are students from overseas, e.g. from Poland, Portugal, Spain, and some of the African countries. Requests have previously been made from them regarding course work for when they go home for the holidays. Therefore these results show that students, who definitely/possibly wish access from abroad total: 47 male (59%) and 58 female (56%) from all the age groups combined. The number of those students, who would not wish this access, is: 14 male (17%) and 23 female (22%) from all the age groups combined (see Appendix 8: Table 62 & 63).

Again there is a greater response of 83% of male staff, who would like access to the UCO from abroad, compared with 26% of female staff (see Appendix 8: Table 64 & 65). These results show that the majority of users would use the virtual desktop, as they could continue to study and keep themselves up to date.

Q37: I would be very happy to use the UCO virtual desktop.

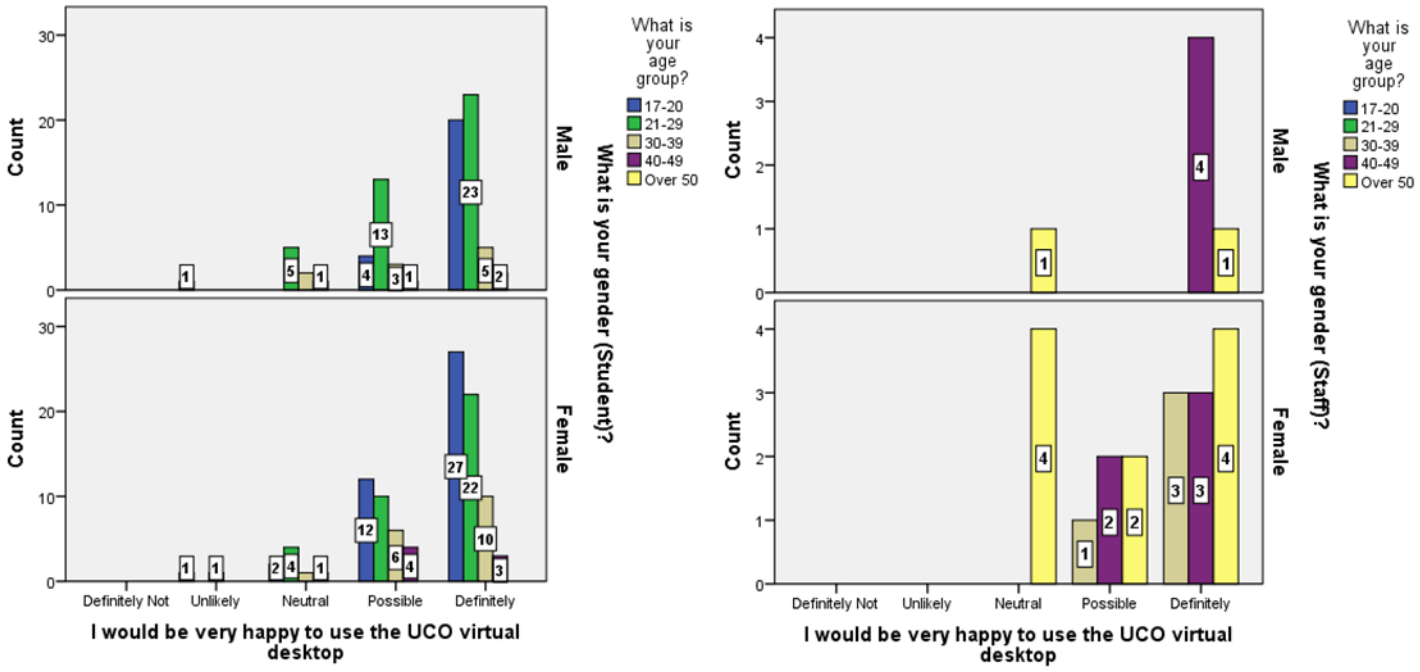


Figure 36: Acceptability of a Virtual Desktop

Figure 36: shows the number of students, who would accept using a virtual desktop in order to access programs from the UCO. These results show that there is a positive feeling about using a virtual desktop from all the age groups combined, i.e. 50 male (63%) and 62 female (60%). There seems to be only one male student (1%) from the 17-20 year age group, who is unlikely to use a virtual desktop and 2 female students (2%); one from the 17-20 year age group and 1 from the 30-39 year age group (see Appendix 8: Table 66 & 67).

It would appear from the staff results that 83% of male and 79% of female staff would accept the virtual desktop; however although there are no negative responses, there were some neutral responses, i.e. 17% male and 21% female (see Appendix 8: Table 68 & 69**)**. These initial results indicate a favourable response for the introduction of a virtual desktop.

4.2 Chapter Summary

Chapter 4 discusses the research findings and analysis of the survey questionnaire. As the UCO is a small campus, it was felt that the survey questionnaire would be sent to all users at the UCO, i.e. staff and students. There was a one hundred per cent return of the questionnaires from all 209 users. There was a varied selection of age groups, i.e. ranging between 17 and 50 years of age and both male and female genders. The survey questionnaire consisted of thirty seven questions, out of which twenty were selected for a more in depth analysis, giving the researcher a clear picture regarding the users' perceived use and acceptance of a virtual desktop. The questions numbered 1-15 were Technology Acceptance related and questions number 16-37 were Usability related. Finally a statistical analysis program (SPSS 20) was used to input and analyse all the appropriate data. This program is a comprehensive system for analysing data. The results could then be produced in both graph and table format, which was the requirement for this research. This visual data allows the reader to see the numbers in a more presentable format. SPSS 20 as already stated allows data to be inputted from most files and then generate reports in either table, graph and/or chart format. It can also if required plot trends and provide complex statistical analyses. This program can be used either by a beginner or an experienced user in statistical analysis, which in this case was for the beginner. Finally having analysed the findings of the research, the next step is to reach some conclusions and possible recommendations, which will be discussed further in Chapter 5 together with key findings from this chapter.

Chapter 5: Conclusions

In Chapter 1 the aim of this research was set out:

"To identify whether a Virtual Desktop is a viable option for the UCO".

Together with research questions:

- *Can a virtual desktop be accepted by both staff and students at the UCO?*
- *How can a virtual desktop benefit all at the UCO?*
- *Are there enough resources at the UCO in the current financial climate?*

This was intended to see whether a virtual desktop service can be achieved within the UCO environment and to determine whether both staff and students would find using a virtual desktop beneficial. Finally this research was to identify whether the virtual desktop would be accepted and useful.

5.1 Goals of Desktop Virtualization

The main aims of a virtual desktop, as we have previously discussed are: saving of space within the data centre; an optimization of the current server hardware; a reduction in the costs of maintaining the server; a cost reduction in both power and cooling; savings on software licenses; a reduction in the server deployment time; and the use of multiple platforms on the same piece of hardware. In this particular research it was determined that desktop virtualization could be a viable option for the UCO. The research showed that it is already being used in a number of organisations and educational establishments having been tested and proven to be acceptable to the users involved.

Citrix surveyed a number of companies in 2013, looking at employees using their own devices at work. The outcome of this survey indicated that within two years there could be approximately 35% of the whole workforce using their own devices. Surprisingly the country, which appears to be the forerunner, is India at 38% (see Figure 37).

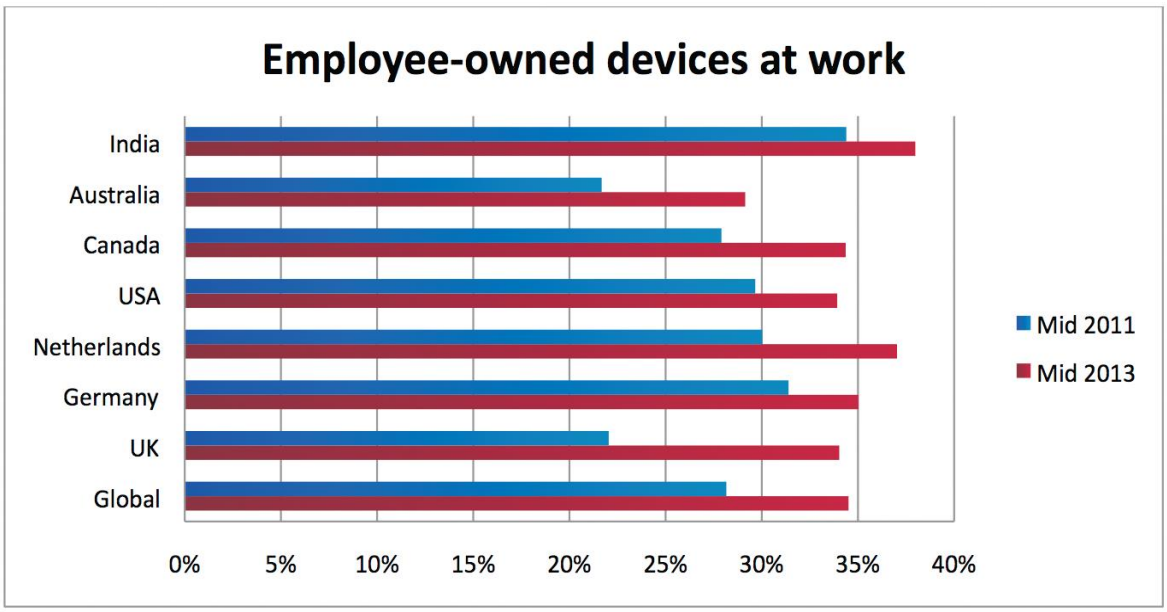


Figure 37: Citrix Global BYO Index (www.citrx.com , 2013)

5.2 Advantages and Disadvantages of Desktop Virtualization for the UCO

The virtual desktop has both advantages and disadvantages, which will now be discussed in greater depth.

5.2.1 Advantages

It is evident from the survey there are many advantages to using the virtual desktop within an educational environment. This research shows that there would not be a need to physically handle each individual computer, as they can be managed at server level. Therefore time could be saved by the IT team when having to deploy new and/or upgrade applications on more than one campus. This also increases the level of security as the data is stored in one place. Currently at the UCO there are two big buildings on one campus and each classroom and office contains numerous computers, not forgetting the Library and Computing Centre (LCC).

Another advantage is that students will have an improved service. This means that they will have 24 hour on demand access to the learning resources at the UCO. They will then have the ability and freedom to access the UCO's applications whenever and wherever they want, as indicated in the survey: *"It would help me greatly being able to access the UCO programs from abroad"* and "*I would not need to worry about the UCO being closed during the holidays as I can still work from home*". The outcome of this could reduce costs in utilities and manpower.

Another saving could come from a reduction in expensive hardware, as desktops and other devices have a longer lifecycle; thereby reducing waste. With the World currently looking to reducing their carbon footprints, it is important that the UCO does the same. The British Computing Society (BSC), 2012 stated that the British Government had announced a 10% target of reducing carbon emissions and that the implementation of a Green IT strategy could save any organisation a great deal of money. The IT strategy for the UCO could be to look at how the life cycle of all IT equipment has an impact on the environment. This would mean addressing the possible issues starting with the suppliers; and deployment of equipment to its disposal. There is a need therefore, to look at the role of IT. On the one side IT is a great consumer of energy, yet on the other it is able to provide innovative solutions, especially in how to reduce carbon emissions. Therefore it is very important for the UCO to bear the Green issue in mind, when the time comes to replace old equipment. The term "eco-friendly" reminds everyone to be more energy efficient and with this in mind the UCO must introduce low energy IT. At is estimated that approximately 5% of energy is used by computers, it is imperative that the UCO addresses the Green issue.

The IT staff at the UCO as already mentioned will be able to deliver a more efficient service from the server level instead of having to visit each PC. Again the benefit to the student will be that they can access their coursework whenever they wish whether it is in the UCO, at home or whilst they are abroad, which would be an enormous advantage for the students from overseas. Furthermore the virtual desktop could be the future for online education, especially for those in foreign countries, wishing a degree from Great Britain. It could also be an in incentive for future students to enrol at the UCO, especially from overseas, which again could increase the revenue for the UCO.

5.2.2 Disadvantages

One major disadvantage at the moment is that students have a lack of understanding what exactly a virtual desktop entails. Training will be a big issue; however in the long term not so much. It is still a new concept, which many people will initially be resistant to. Fortunately this was not apparent from the survey as there appeared to be no resistance to the implementation of a virtual desktop. Although the students would have complete control of the virtual machine, there could be a problem for the tutors as they would not be able to monitor the activity or what goes on the machines. Therefore the administrator rights would need to be decided at the outset as to who would have them.

It has to be said that not all hardware or software will work with the virtualization platform. It is essential to determine at the design stage what would be needed. In this instance there could be a cost implication and whether funding was available. As the UCO is only a small establishment, it is unclear whether there would be enough funding for this. If it was to be considered, then a business case may need to be put to the Principal of the UCO.

One point to consider is that should the virtual desktop be accepted for development at the UCO, how would affect the IT staff? As previously mentioned, the virtual desktop would enable the IT staff to spend more time on other urgent matters, so would that mean there could be job losses, if there was not enough work to do for the numbers of IT staff?

In view of all that has been stated, it can only be to the UCO's benefit to seriously consider implementing the virtual desktop. The advantages far outweigh the disadvantages and all things considered the virtual desktop is the future. Education at all levels needs to be as efficient in its delivery as much as possible, probably more so for those in higher education.

5.3 Key Findings

The findings of this survey as discussed in Chapter 4 were very interesting. Various factors emerged demonstrating the need to implement the virtual desktop. One such factor was the ability to use the desktop remotely:

5.3.1 End-User Mobility

As stated in Chapter 4, both staff and students felt working from home would be very advantageous. Question 27 (Appendix 5: Virtual Desktop Questionnaire) showed that the academic staff would probably have more time for preparation work by working from home and that the students, especially the more senior ones, would probably get more work done from home. The younger age groups did not appear to agree with. Could it possibly be that they are still in the "fresher" mind-set whereby they assume that the hard work does not really start until the second and third years of their course? Also there could be the ability for the overseas students to carry on with their course work during the holidays, when they had gone home. This would allow them to have the same access as those nearer to the UCO. However, it would probably not be used by those going overseas on holiday, but those serious minded students may very well take advantage of this. At the very least it could be available wherever they were in the world. This could be the future by increasing mobility for a global workforce.

5.3.2 Reduction in Costs

Already we have seen that the students could save money by not investing such expensive software programs (Appendix 9: Licence costs). The UCO could also save from a reduction in energy consumption, i.e. less computer use in the UCO; less usage of all utilities; less wastage; and in time there could be a reduction in employment costs as there may not be the need for as many IT support staff in the future.

5.3.3 Data Security

Question 25 (Appendix 5: Virtual Desktop Questionnaire) of the survey addressed the security of the virtual desktop. The results showed that all users were unsure as to how secure the system could be. This indicated that the UCO would need to organize training sessions and devise help guides in order to reassure everyone that the virtual desktop would be safe to use, at home as well as at the UCO, even when using their own devices. As stated on pages 9-10 of this research, security could be a problem if not addressed correctly.

5.3.4 Environmental Factors

As previously discussed the "Green" issue is a very important concern that needs addressing. The virtual desktop would allow the UCO to upgrade systems without having to change software and computers needlessly. A reduction of the UCO's carbon footprint, would contribute to making the environment greener. Another benefit would be noise reduction. If the majority of users were using the virtual desktop from home, then the UCO could be a quieter place to work and/or study.

5.4 The Future of Virtualization at the UCO

Virtualization appears to be something that "***must***" take place rather than "***should***". A lack of a business plan as well as a risk management strategy has been shown to put organizations at risk (KMworld, 2010). One method of addressing this issue is by using virtualization (or the cloud). It has already been stated that virtualization provides a service, whereby there is a reduction in costs as well as total cost of ownership.

It will be able to offer all users the opportunity to work with a range of different applications that would not normally be available on the desktop computer. They would be able to undertake a multitude of tasks not previously available to them. They would not have to travel to the UCO as the virtual desktop could be accessed from anywhere and at any time of the day. This would also have an impact on the laptop loans, which occurs prior to any of the holidays. Currently both students and academic staff are able loan a laptop from the UCO, which would not be necessary with a virtual desktop, as it could be accessed from any device, again making savings. With a reduction in overall costs, the UCO could benefit enormously from this, thus being able to use any extra resources in other vital areas.

Finally the virtual desktop would be of great value to those academic staff, who needs to promote the courses provided by the UCO to possible overseas students. This could reduce costs further as they may not need to go overseas as often.

5.5 Lessons Learned

In order to undertake this research, certain criteria were looked at. It is hoped that the outcomes have been discussed and addressed. These included:

- Identifying solutions that would enable deployment of the virtual desktop
- Addressing the lack of knowledge surrounding virtualization
- Identifying the lack of expertise regarding new technology
- Users being able to accept new technology
- The virtual desktop being able to support the users' needs
- Uncertainty surrounding security of the virtual desktop

However, there were concerns at the end that the researcher needs to add at this point with some clarification. After the survey had ended and the results analysed, it was thought in hindsight that there was the opportunity to ask other questions, which were missed, e.g. questions regarding computer specifications. The answers to this question could determine whether the user would be able to access the virtual desktop as their own device might need to be upgraded or even changed to meet the specifications of the virtual desktop. This would almost certainly have a cost implication to the user.

Also there was the question regarding the ethnicity of users. The UCO caters for overseas students and although English is the chosen language there could have been barriers when undertaking the survey, which were not considered at the time. However, with 100% compliance of the survey, it was assumed that they did not experience any problems.

It was also determined that maybe too many programs were initially included in the survey. It could have been more prudent to be more selective especially to the ones pertaining to the current courses being delivered at the UCO. This would mean that there would then be the possibility of creating different virtual desktops for different courses. This would then add to the savings for the UCO, as this would save on the cost of licenses. Again consideration was not made at the time regarding the size of the UCO as this would then depend on how many virtual desktops would initially be required.

Another observation made later, was that the staff questioned in the survey cannot be determined as to whether they are academic or non-academic staff. Their answers would

probably have differed as the administrative staff would probably not want to have to work from home or when they are on holiday (non-academic staffs do not have extended holidays during the summer).

It was felt that the above need to be added here as an addendum due to oversights made during the research.

5.6 Chapter Summary

Chapter 5 looked at the conclusions found from undertaking this particular piece of research. The advantages and disadvantages of a virtual desktop were discussed together with the key findings of the survey undertaken (Chapter 4). Also the future of the virtual desktop at the UCO was discussed, which clearly indicates that there is a need but whether this will become reality, will depend on resources and whether the Principal embraces the idea.

Finally there were omissions made and realizations of what should have been included in the survey, which hopefully have now been clarified.

Appendices:

Appendix 1: ISO 17799 (Security policy)

TABLE 1 ISO/IEC 17799, Sections A.3 through A.12

ISO/IEC 17799 Sections	Notes
A.3 SECURITY POLICY	
A.3.1 Information security policy	
A.3.1.1 *Information security policy document*	Policy manuals support management's assessment of its controls (PCAOB, 2004, para. 43). Security policies form the basis for both IT general controls (para. 40) and specific controls over financial reporting (para. 40) that are part of integrity assurance component of information security (ISO, 2000, p. viii).
A.3.1.2 *Review and evaluation*	Quarterly internal assessments of the controls, including policies, and annual assessments by outside auditors are required by the Act (Hardesty, 2003, pp. 3026, 3036). There is no specified frequency for review under ISO 17799 (2000, p. 2); therefore, this is a case where the requirements of the Sarbanes–Oxley Act are more stringent than the ISO Standard.
A.4 ORGANIZATIONAL SECURITY	
A.4.1 Information security infrastructure	
A.4.1.1 *Management information security forum*	There appears to be nothing in the legislation or the supporting regulations that require any of these infrastructure items.
A.4.1.2 *Information security coordination*	There appears to be nothing in the legislation or the supporting regulations that require any of these infrastructure items.
A.4.1.3 *Allocation of information security responsibilities*	There appears to be nothing in the legislation or the supporting regulations that require any of these infrastructure items.
A.4.1.4 *Authorization process for information processing facilities*	No bearing on the focus or intent of the Act.
A.4.1.5 *Specialist information security advice*	No bearing on the focus or intent of the Act.
A.4.1.6 *Cooperation between organizations*	No bearing on the focus or intent of the Act.
A.4.1.7 *Independent review of information security*	For those items that are common to ISO 17799 and SOX, the ISO requirement for review and evaluation will probably be satisfied by the annual outside auditor evaluation of management's assessment of its internal controls.
A.4.2 Security of third-party access	
A.4.2.1 *Identification of risks from third-party access*	The entire risk assessment process is one of the factors that the auditor must evaluate according to the PCAOB (2004, para. 49). If third parties have access to financial systems, either directly or indirectly, then this item would be pertinent to SOX compliance.
A.4.2.2 *Security requirements in third-party contracts*	This is one component of IT general controls specified by the PCAOB (2004, para. 50).
A.4.3 Outsourcing	
A.4.3.1 *Security requirements in outsourcing contracts*	It is noted that the ISO neglected to include a risk assessment component under this section but included risk assessment for third-party access. It is assumed that this is a mere oversight and that risk assessment would be a best practice for outsourcing contracts. For completeness, all outsourcing contracts should be evaluated for risks, and security requirements should be included in those contracts where appropriate. This would satisfy paragraphs 49 and 50 of AS No. 2 (PCAOB, 2004). The list of contractual terms under third-party access is recommended for outsourcing contracts (ISO, 2000, p. 8).
A.5 ASSET CLASSIFICATION AND CONTROL	
A.5.1 Accountability for assets	
A.5.1.1 *Inventory of assets*	First step to prevent misappropriation of company assets, which is a requirement under AS No. 2, para. 24. The inventory of assets becomes part of the IT general controls listed in Paragraph 40 (PCAOB, 2004).

TABLE 1 ISO/IEC 17799, Sections A.3 through A.12 (Continued)

ISO/IEC 17799 Sections	Notes
A.5.2 Information classification	
A.5.2.1 *Classification guidelines*	Classification does not seem to have a bearing on data integrity, the primary concern of the Act, and therefore is not relevant to compliance with the Act.
A.5.2.2 *Information labeling and handling*	Labeling does not seem to have a bearing on data integrity, the primary concern of the Act, and therefore is not relevant to compliance with the Act.
A.6 PERSONNEL SECURITY	
A.6.1 Security in job definition and resourcing	
A.6.1.1 *Including security in job responsibilities*	One component of the general controls that provide foundation for more specific controls as described in Paragraphs 40 and 50 (PCAOB, 2004). Such a practice may also be viewed as a significant part of the control environment discussed in Paragraph 53 (PCAOB, 2004).
A.6.1.2 *Personnel screening and policy*	Such practices are a significant part of the general controls of Paragraphs 40 and 50; they may also be regarded as a specific control to prevent fraud, thus satisfying in part the requirements of Paragraphs 25 and 40 (PCAOB, 2004).
A.6.1.3 *Confidentiality agreements*	The use or non-use of *confidentiality agreements* does not have a direct bearing on the provisions of the Act nor on any of the provisions of AS No. 2 (PCAOB, 2004).
A.6.1.4 *Terms and conditions of employment*	*Terms and conditions of employment*, when coupled with security in job responsibilities (above), can be a major part of the control environment of Paragraph 53 (PCAOB, 2004).
A.6.2 User training	
A.6.2.1 *Information security education and training*	An *information security education and training* program serves as evidence of the strength of the control environment and the "tone at the top" that is the subject of Paragraph 40. Such a program is also part of the "information technology general controls" that are to be included in the evaluation of management's assessment prescribed by Paragraph 53 (PCAOB, 2004).
A.6.3 Responding to security incidents and malfunctions	
A.6.3.1 *Reporting security incidents*	A detective control and possibly the last line of preventive control in the right circumstances. Such reporting may be used as input to management's assessment of its controls. Such measures would fall into the category of controls to monitor other controls listed under company-level controls in Paragraph 53 (PCAOB, 2004).
A.6.3.2 *Reporting security weaknesses*	A detective control and possibly the last line of preventive control in the right circumstances. Such reporting may be used as input to management's assessment of its controls. Such measures would fall into the category of controls to monitor other controls listed under company-level controls in Paragraph 53 (PCAOB, 2004).
A.6.3.3 *Reporting software malfunctions*	A detective control and possibly the last line of preventive control in the right circumstances. Such reporting may be used as input to management's assessment of its controls. Such measures would fall into the category of controls to monitor other controls listed under company-level controls in Paragraph 53 (PCAOB, 2004).
A.6.3.4 *Learning from incidents*	Part of management's ongoing risk assessment and the basis for identifying improved controls.
A.6.3.5 *Disciplinary process*	Evidence of management's effort to set the "tone at the top," as well as being good management practice.
A.7 PHYSICAL AND ENVIRONMENTAL SECURITY	
A.7.1 Secure areas	
A.7.1.1 *Physical security perimeter*	All controls are components of IT general controls (PCAOB, 2004, para. 50).
A.7.1.2 *Physical entry controls*	All controls are components of IT general controls (PCAOB, 2004, para. 50).
A.7.1.3 *Securing offices, rooms and facilities*	All controls are components of IT general controls (PCAOB, 2004, para. 50).
A.7.1.4 *Working in secure areas*	All controls are components of IT general controls (PCAOB, 2004, para. 50).

TABLE 1 ISO/IEC 17799, Sections A.3 through A.12 (Continued)

ISO/IEC 17799 Sections	Notes
A.7.1.5 *Isolated delivery and loading areas*	Contributes to the security of inbound and outbound merchandise and equipment and is a company-level control (PCAOB, 2004, para. 53).
A.7.2 Equipment security	
A.7.2.1 *Equipment setting and protection*	The Act requires management to report on controls that are designed to support the issuer's "ability to record, process, summarize and report financial data …" with the emphasis on the word "ability" (Hardesty, 2004, p. 3027).
A.7.2.2 *Power supplies* — Equipment shall be protected from power failures and other electrical anomalies	The Act requires management to report on controls that are designed to support the issuer's "ability to record, process, summarize and report financial data …" with the emphasis on the word "ability" (Hardesty, 2004, p. 3027).
A.7.2.3 *Cabling security*	The security of data cables against surreptitious connections is important as control against insertion of fraudulent data into data streams.
A.7.2.4 *Equipment maintenance*	The Act requires management to report on controls that are designed to support the issuer's "ability to record, process, summarize and report financial data …" with the emphasis on the word "ability" (Hardesty, 2004, p. 3027).
A.7.2.5 *Security of equipment off-premises*	Is a SOX relevant issue to the extent that the equipment that is off premises may be used to gain access to the financial processing systems or to the financial data directly.
A.7.2.6 *Secure disposal or re-use of equipment*	Relevant to protecting access and integrity controls if the equipment contains information that could be used to circumvent those controls.
A.7.3 General controls	
A.7.3.1 *Clear desk and clear screen policy*	The *clear desk and clear screen policy* falls into the IT general controls of AS No. 2, Paragraph 50 (PCAOB, 2004).
A.7.3.2 *Removal of property*	May be relevant to protecting financial data integrity controls if the property contains information that could be used to circumvent those controls; such controls are necessary in preventing misappropriation of company assets which is covered by AS No. 2, Paragraph 24 (PCAOB, 2004).
A.8 COMMUNICATIONS AND OPERATIONS MANAGEMENT	
A.8.1 Operational procedures and responsibilities	
A.8.1.1 *Documented operating procedures*	The operating procedures contain directions for processing financial data, the operating procedures become part of management's documentation addressed in AS No. 2, Paragraphs 42 and 43 (PCAOB, 2004).
A.8.1.2 *Operational change controls*	Is specifically mentioned in Paragraph 50 as being part of the IT general controls (PCAOB, 2004).
A.8.1.3 *Incident management procedures*	Covers procedures for dealing with processing errors and fraudulent entries that fall under the scope of the legislation and AS No. 2, Paragraph 49 (PCAOB, 2004). The multiple aspects of these procedures described in the ISO Standard make incident management procedures a key component for detection and recovery from errors and frauds (International Organization for Standardization, 2000, pp. 20–21).
A.8.1.4 *Segregation of duties*	Should be planned with a view to preventing fraud and other security failures according to the ISO Standard (International Organization for Standardization, 2000, p. 21). Segregation of duties is specifically identified as a part of management's documentation of controls (PCAOB, 2004, para. 42).
A.8.1.5 *Separation of development and operational facilities*	This is one more component of IT general controls (PCAOB, 2004, para. 50). It is a specific control to prevent accidental corruption of financial data during development and testing.
A.8.1.6 *External facilities management*	May be an issue under the Act and AS No. 2 if financial data processing is outsourced. Should such outsourcing be done, all controls necessary to assure the integrity of that financial data must be applied.
A.8.2 System planning and acceptance	
A.8.2.1 *Capacity planning*	This control is a component of compliance with the Act because the Act requires management to report on controls that are designed to support the issuer's "ability to record, process, summarize and report financial data …" with the emphasis on the word "ability" (Hardesty, 2004, p. 3027).

TABLE 1 ISO/IEC 17799, Sections A.3 through A.12 (Continued)

ISO/IEC 17799 Sections	Notes
A.8.2.2 *System acceptance*	Another component of IT general controls (PCAOB, 2004, para. 50). Testing must cover the range of controls designed to preserve the integrity of that data, and that testing would be part of compliance with AS No.2, Paragraph 40 (PCAOB, 2004).
A.8.3 Protection against malicious software	
A.8.3.1 *Controls against malicious software*	The Act requires management to report on controls that are designed to support the issuer's "ability to record, process, summarize and report financial data …" with the emphasis on the word "ability" (Hardesty, 2004, p. 3027).
A.8.4 Housekeeping	
A.8.4.1 *Information back-up*	Another of the controls designed to support the issuer's "ability to record, process, summarize and report financial data …" (Hardesty, 2004, p. 3027). Backups also may be used to detect data integrity failures through comparison and reconciliation programs; thus backups may be a control activity in accordance with Paragraph 49 (PCAOB, 2004).
A.8.4.2 *Operator logs*	An IT general control, and may be a specific control to detect failures related to data integrity and therefore be control activities in accordance with Paragraph 49 (PCAOB, 2004).
A.8.4.3 *Fault logging*	An IT general control, and may be a specific control to detect failures related to data integrity and therefore be control activities in accordance with Paragraph 49 (PCAOB, 2004).
A.8.5 Network management	
A.8.5.1 *Network controls*	Another in the category of IT general controls (PCAOB, 2004, para. 50). Some network controls may be specific controls to prevent or detect compromises of data integrity in accordance with Paragraph 49 (PCAOB, 2004).
A.8.6 Media handling and security	
A.8.6.1 *Management of removable computer media*	As controls to prevent reconnaissance by someone intent on fraud or denial of service, they become items of the IT general controls (PCAOB, 2004, para. 50).
A.8.6.2 *Disposal of media*	As controls to prevent reconnaissance by someone intent on fraud or denial of service, they become items of the IT general controls (PCAOB, 2004, para. 50).
A.8.6.3 *Information handling procedures*	As controls to prevent reconnaissance by someone intent on fraud or denial of service, they become items of the IT general controls (PCAOB, 2004, para. 50).
A.8.6.4 *Security of system documentation*	As controls to prevent reconnaissance by someone intent on fraud or denial of service, they become items of the IT general controls (PCAOB, 2004, para. 50).
A.8.7 Exchanges of information and software	
A.8.7.1 *Information and software exchange agreements*	Such agreements are components of IT general controls specified in Paragraph 50; such agreements may also contain specific controls to prevent or detect compromises of data integrity in accordance with Paragraph 49 (PCAOB, 2004).
A.8.7.2 *Security of media in transit*	Such controls are part of IT general controls; however, specific controls to prevent/detect compromises of data integrity are mandated by Paragraph 49 (PCAOB, 2004).
A.8.7.3 *Electronic commerce security*	These controls are required in accordance with Paragraph 49 (PCAOB, 2004). A significant issue may be nonrepudiation controls to ensure the authenticity of the source of transactions. Moreover, these controls must be documented so as to support the auditor's walkthrough that is required by Paragraph 80 (PCAOB, 2004).
A.8.7.4 *Security of electronic mail*	Over and above the general controls, specific controls to preserve and protect whistleblower communications may be required as part of the disclosure controls mandated by Section 302 (a)(4)(a) (Hardesty, 2003, p. 3026).
A.8.7.5 *Security of electronic office systems*	These controls are components of IT general controls described in Paragraph 50 (PCAOB, 2004). To the degree that any of these systems are used to record, process, or summarize financial data, they become subject to controls required by the Act and Paragraph 49 (PCAOB, 2004).
A.8.7.6 *Publicly available systems*	These controls are components of IT general controls described in Paragraph 50 (PCAOB, 2004). To the degree that any of these systems are used to record, process, or summarize financial data they become subject to controls required by the Act and Paragraph 49 (PCAOB, 2004).

TABLE 1 ISO/IEC 17799, Sections A.3 through A.12 (Continued)

ISO/IEC 17799 Sections	Notes
A.8.7.7 *Other forms of information exchange*	These controls are components of IT general controls described in Paragraph 50 (PCAOB, 2004). To the degree other forms of information exchange are used to initiate, record, process, or summarize financial data, they become subject to controls required by the Act and Paragraph 49 (PCAOB, 2004).
A.9 ACCESS CONTROL	
A.9.1 Business requirement for access control	
A.9.1.1 *Access control policy*	Policy manuals are identified in Paragraph 43 as a form of management documentation used as a basis for the auditor's evaluation (PCAOB, 2004). Under Paragraph 43, access control policy should address all of the elements outlined in Paragraph 49 (PCAOB, 2004). Security policies form the basis for both IT general controls and specific controls over financial reporting that are part of integrity assurance component of information security (ISO, 2000, p. viii).
A.9.2 User access management	
A.9.2.1 *User registration*	User registration is a component of IT controls upon which other controls depend (PCAOB, 2004. para. 50).
A.9.2.2 *Privilege management*	Privilege management is a component of IT controls upon which other controls depend (PCAOB, 2004. para. 50).
A.9.2.3 *User password management*	User password management is a component of IT controls upon which other controls depend (PCAOB, 2004. para. 50).
A.9.2.4 *Review of user access rights*	Review of user access rights is a component of IT controls upon which other controls depend (PCAOB, 2004. para. 50).
A.9.3 User responsibilities	
A.9.3.1 *Password use*	Policies on password use are components of IT general controls (PCAOB, 2004, para. 50). These policies, when enforced and coupled with system logs of user activity, become a key control to prevent surreptitious access and fraud in electronically processed data.
A.9.3.2 *Unattended user equipment*	Policies on unattended user equipment are components of IT general controls (PCAOB, 2004, para. 50). These policies, when enforced and coupled with system logs of user activity, become a key control to prevent surreptitious access and fraud in electronically processed data.
A.9.4 Network access control	
A.9.4.1 *Policy on use of network services*	Such a policy forms the basis for both IT general controls (PCAOB, 2004, para. 50) and specific controls over financial reporting that are part of integrity assurance component of information security (ISO, 2000, p. viii).
A.9.4.2 *Enforced path*	A control activity under Paragraph 49 (PCAOB, 2004) when it is applied.
A.9.4.3 *User authentication for external connections*	A control activity under Paragraph 49 (PCAOB, 2004). When enforced and coupled with logs of user activity, become a key control to prevent surreptitious access and fraud in electronically processed data.
A.9.4.4 *Node authentication*	A control activity under Paragraph 49 (PCAOB, 2004). Because of the capability to forge source addresses on network packets, authentication on the basis of source node alone is generally not considered a desirable method of authentication.
A.9.4.5 *Remote diagnostic port protection*	One component of IT general controls (PCAOB, 2004, para. 50).
A.9.4.6 *Segregation in networks*	One component of IT general controls (PCAOB, 2004, para. 50). When financial data and financial processing is placed on servers that are segregated in a restricted subnet, segregation may be a significant control to restrict access and preserve the integrity of financial data under Paragraph 49 (PCAOB, 2004).
A.9.4.7 *Network connection control*	One component of IT general controls (PCAOB, 2004, para. 50). It can be a significant control to prevent or restrict access and preserve the integrity of financial data in accordance with Paragraph 49 (PCAOB, 2004).
A.9.4.8 *Network routing control*	One component of IT general controls upon which other security measures depend (PCAOB, 2004, para. 50).
A.9.4.9 *Security of network services*	One component of IT general controls upon which other security measures depend (PCAOB, 2004, para. 50).

TABLE 1 ISO/IEC 17799, Sections A.3 through A.12 (Continued)

ISO/IEC 17799 Sections	Notes
A.9.5 Operating system access control	
A.9.5.1 *Automatic terminal identification*	May be needed to prevent surreptitious access and fraud in financial data. When implemented, this procedure would be a control under Paragraph 49 (PCAOB, 2004).
A.9.5.2 *Terminal log-on procedures*	Key controls to prevent surreptitious access and fraud in electronically processed data in accordance with Paragraph 49 (PCAOB, 2004).
A.9.5.3 *User identification and authentication*	Key controls to prevent surreptitious access and fraud in electronically processed data in accordance with Paragraph 49 (PCAOB, 2004).
A.9.5.4 *Password management system*	Another component of IT general controls (PCAOB, 2004, para. 50). If user identification and authentication is accomplished by means of passwords, then the password management system is a key element and must be examined very closely for weaknesses because all other integrity measures depend on it.
A.9.5.5 *Use of system utilities*	Restriction on the use of system utilities is another component of IT general controls (PCAOB, 2004, para. 50).
A.9.5.6 *Duress alarm to safeguard users*	The implementation of a duress alarm to safeguard users is not significant to the goals of the Act and is therefore deemed to be beyond the scope of the Act.
A.9.5.7 *Terminal time-out*	A component of IT general controls (PCAOB, 2004, para. 50). It is also an important control to prevent unauthorized access to financial data in accordance with Paragraph 49 (PCAOB, 2004).
A.9.5.8 *Limitation of connection time*	A component of IT general controls (PCAOB, 2004, para. 50). It is also an important control to prevent unauthorized access to financial data in accordance with Paragraph 49 (PCAOB, 2004).
A.9.6 Application access control	
A.9.6.1 *Information access restriction*	A key control to prevent unauthorized access to financial data in accordance with Paragraph 49 (PCAOB, 2004). All of the measures identified in the ISO Standard (ISO, 2000, p. 43) are reasonable and necessary for assuring financial data integrity as envisioned by the Act.
A.9.6.2 *Sensitive system isolation*	May be a necessary measure, depending on management's risk assessment. Should it be deemed necessary, this measure becomes a control under Paragraph 49 (PCAOB, 2004).
A.9.7 Monitoring system access and use	
A.9.7.1 *Event logging*	Needed to detect unauthorized access to financial systems and data and considered a key control activity under Paragraph 49 (PCAOB, 2004).
A.9.7.2 *Monitoring system use*	Includes what risk factors should be considered, what to log, and when to review the logs (ISO, 2000, pp. 44–45). This is a key control activity under Paragraph 49 (PCAOB, 2004).
A.9.7.3 *Clock synchronization*	Another measure that falls into the category of IT general controls (PCAOB, 2004, para. 50).
A.9.8 Mobile computing and teleworking	
A.9.8.1 *Mobile computing*	A component of the IT general controls of Paragraph 50 (PCAOB, 2004). Specific issues and controls and particular concerns are expressed regarding unauthorized remote access to systems (ISO, 2002, pp. 46–47). Each of these may become a control activity under Paragraph 49 (PCAOB, 2004) if access to financial data is available or financial processing is performed using these remote technologies.
A.9.8.2 *Teleworking*	A component of the IT general controls of Paragraph 50 (PCAOB, 2004). ISO provides some details about specific issues and controls, and particular concerns are expressed regarding unauthorized remote access to systems (ISO, 2002, pp. 46–47). Each of these may become a control activity under Paragraph 49 (PCAOB, 2004) if access to financial data is available or financial processing is performed using these remote technologies.
A.10 SYSTEMS DEVELOPMENT AND MAINTENANCE	
A.10.1 Security requirements of systems	
A.10.1.1 *Security requirements analysis and specification*	Another of the IT general controls under Paragraph 50 (PCAOB, 2004). Documentation may become part of management's documentation of its internal controls under Paragraph 43 (PCAOB, 2004).

TABLE 1 ISO/IEC 17799, Sections A.3 through A.12 (Continued)

ISO/IEC 17799 Sections	Notes
A.10.2 Security in application systems	
A.10.2.1 *Input data validation*	A significant consideration and becomes a key control under Paragraph 49 (PCAOB, 2004). Documentation of the manual processes may usually be found in procedure manuals and are part of management's documentation (PCAOB, 2004, para. 43). A firm may arrive at the position in which key controls are in place and operating effectively but for which adequate documentation is unavailable for either management's assessment, Paragraph 43, or the auditor's walkthrough, Paragraph 80 (PCAOB, 2004).
A.10.2.2 *Control of internal processing*	Provides for the special controls that may be needed to ensure processing conforms to GAAP. This is a key control under Paragraph 49 (PCAOB, 2004). Once again the firm may find itself with inadequate documentation as described above.
A.10.2.3 *Message authentication*	To the extent that financial transactions are entered into the system from message traffic, this becomes a key control over financial data under Paragraph 49 (PCAOB, 2004).
A.10.2.4 *Output data validation*	May be needed to ensure outputs are reconciled in accordance with GAAP. As such, this becomes another key control over financial data under Paragraph 49 (PCAOB, 2004).
A.10.3 Cryptographic controls	
A.10.3.1 *Policy on the use of cryptographic controls*	One or more policies that form the basis for both IT general controls and specific controls over financial reporting under Paragraph 40 (PCAOB, 2004). The focus is on the integrity assurance component of information security (ISO, 2000, p. viii). This policy becomes a part of management's documentation under Paragraph 43 and should address all of the elements outlined in Paragraph 49 (PCAOB, 2004).
A.10.3.2 *Encryption*	May be used to ensure data integrity and, if so used, a key control under Paragraph 49 (PCAOB, 2004).
A.10.3.3 *Digital signatures*	May be needed to ensure the integrity of data communicated through open networks and therefore may be a key control under Paragraph 49 (PCAOB, 2004).
A.10.3.4 *Non-repudiation services*	May also be needed to ensure the authenticity of financial transactions communicated through open networks and to screen out fraudulent transactions. Such controls also become key controls under Paragraph 49 (PCAOB, 2004).
A.10.3.5 *Key management*	Needed only if cryptography is used for authentication or integrity controls and becomes one of the IT general controls upon which other controls depend (PCAOB, 2004, para. 50).
A.10.4 Security of system files	
A.10.4.1 *Control of operational software*	One component of IT general controls within the purview of Paragraph 50 (PCAOB, 2004).
A.10.4.2 *Protection of system test data*	A component of IT general controls within the purview of Paragraph 50 (PCAOB, 2004).
A.10.4.3 *Access control to program source library*	One component of IT general controls that is specifically mentioned in Paragraph 50 (PCAOB, 2004).
A.10.5 Security in development and support processes	
A.10.5.1 *Change control procedures*	A component of IT general controls that is specifically mentioned in Paragraph 50 (PCAOB, 2004).
A.10.5.2 *Technical review of operating system changes*	One component of IT general controls under Paragraph 50 (PCAOB, 2004).
A.10.5.3 *Restrictions on changes to software packages*	Another component of IT general controls under Paragraph 50 (PCAOB, 2004).
A.10.5.4 *Covert channels and Trojan code*	Additional security issues, the controls for which are IT general controls under Paragraph 50 (PCAOB, 2004).
A.10.5.5 *Outsourced software development*	Another component of IT general controls under Paragraph 50 (PCAOB, 2004).

TABLE 1 ISO/IEC 17799, Sections A.3 through A.12 (Continued)

ISO/IEC 17799 Sections	Notes
A.11 BUSINESS CONTINUITY MANAGEMENT	
A.11.1 Aspects of business continuity management	
A.11.1.1 *Business continuity management process*	A component of a continuity of operations plan that may be inferred from the language of the Act in which controls are designed to support the issuer's "ability to record, process, summarize, and report financial data …" (Hardesty, 2003, p. 3027).
A.11.1.2 *Business continuity and impact analysis*	A component of a continuity of operations planning process that may be inferred from the language of the Act in which controls are designed to support the issuer's "ability to record, process, summarize, and report financial data …" (Hardesty, 2003, p. 3027).
A.11.1.3 *Writing and implementing continuity plans*	A component of a continuity of operations planning process that may be inferred from the language of the Act in which controls are designed to support the issuer's "ability to record, process, summarize, and report financial data …" (Hardesty, 2003, p. 3027).
A.11.1.4 *Business continuity planning framework*	An aspect of a continuity of operations planning process that may be inferred from the language of the Act in which controls are designed to support the issuer's "ability to record, process, summarize, and report financial data …" (Hardesty, 2003, p. 3027).
A.11.1.5 *Testing, maintaining, and re-assessing business continuity plans*	Because the evaluations are tied to periodic financial reports, the Act requires more frequent and more detailed evaluations than the ISO Standard, which has no mention of timing of evaluations.
A.12 COMPLIANCE	
A.12.1 Compliance with legal requirements	
A.12.1.1 *Identification of applicable legislation*	Because of continuing changes in the law and the regulatory environments (the Sarbanes–Oxley Act of 2002 is an example), this must be an ongoing activity.
A.12.1.2 *Intellectual property rights (IPR)*	These areas are covered by existing legislation or legal precedent.
A.12.1.3 *Safeguarding of organizational records*	These areas are covered by existing legislation or legal precedent.
A.12.1.4 *Data protection and privacy of personal information*	These areas are covered by existing legislation or legal precedent; however, recent incidents may motivate additional legislation that may impose stricter requirements.
A.12.1.5 *Prevention of misuse of information processing facilities*	These areas are covered by existing legislation or legal precedent.
A.12.1.6 *Regulation of cryptographic controls*	These areas are covered by existing legislation.
A.12.1.7 *Collection of evidence*	There seems to be no intent in the Act to mandate prosecution of those who commit fraud, only that the fraud be detected and reported (Hardesty, 2003, p. 3027). Therefore, it appears that procedures for the collection of evidence are beyond the scope of the Act.
A.12.2 Reviews of security policy and technical compliance	
A.12.2.1 *Compliance with security policy*	A component that the ISO Standard has in common with the Act and AS No. 2. As with legal compliance (above), the ISO Standard suggests no timing other than "regular reviews" (ISO, 2002, p. 64).
A.12.2.2 *Technical compliance checking*	A component that the ISO Standard has in common with the Act and AS No. 2. As with legal compliance (above), the ISO Standard suggests no timing other than "regular reviews" (ISO, 2002, p. 64).
A.12.3 System audit considerations	
A.12.3.1 *System audit controls*	These form part of the IT general controls and provide one means for management to evaluate the effectiveness of other IT controls (PCAOB, 2004, para. 49).
A.12.3.2 *Protection of system audit tools*	The suite of tools used to audit information systems must be reviewed regularly to ensure coverage of the IT general controls and the specific controls over financial reporting. These appear to fall under the monitoring area of Paragraph 49 (PCAOB, 2004).

Appendix 2: Definitions of TAM Variables and Related Models

Variable	Definition	Models that include the variable
Behaviour	The action, specific or general, whose prediction is of interest	TRA/TPB
Use (USE)	One specific behaviour of interest performed by individuals with regard to some information technology (IT) system	TAM, TAM2, UTAUT
Behavioural intention (BI)	An individual's motivation or willingness to exert effort to perform the target behaviour	TAM, TAM2, UTAUT, TRA/TPB
Attitude (ATT)	An individual's evaluative judgment of the target behaviour on some dimension (e.g., good/bad, harmful/beneficial, pleasant/unpleasant)	TAM, TRA/TPB
Perceived ease of use (PEOU)	An individual's perception that using an IT system will be free of effort	TAM, TAM2
Perceived usefulness (PU)	An individual's perception that using an IT system will enhance job performance	TAM, TAM2
Subjective norm (SN)	An individual's perception of the degree to which important other people approve or disapprove of the target behaviour	TAM2, TRA/TPB
Perceived Behavioural Control (PBC)	An individual's perception of how easy or difficult it will be to perform the target behaviour (self-efficacy), of factors that impede or facilitate the behaviour (facilitating conditions), or of the amount of control that one has over performing the behaviour (controllability)	TPB
Effort expectancy	(See PEOU)	UTAUT
Performance expectancy	(See PU)	UTAUT
Social influence	(See SN)	UTAUT
Facilitating conditions	(See PBC)	UTAUT
Image, job relevance, output quality, results demonstrability	Real or perceived characteristics of IT that influence its PU	UTAUT
Behavioural beliefs,	An individual's perceptions about specific positive/negative outcomes of performing the target behaviour, specific groups or	TRA/TPB

normative beliefs, control beliefs	people who encourage/discourage the behaviour, and specific factors or circumstances that make behaviour easier/more difficult	

- **TAM** = Technology Acceptance Model.
- **TAM2** = Technology Acceptance Model 2.
- **UTAUT** = Universal Theory of Acceptance and Use of Technology.
- **TRA** = Theory of Reasoned Action.
- **TPB** = Theory of Planned Behaviour

These resources are available to download from: www.ncbi.nlm.nih.gov, 2010

Appendix 3: Factors Affecting Information System Satisfaction (Bailey, J. E. Pearson, S.W, 1993)

Listed in order of importance as determined by Bailey & Pearson:

1. Top management involvement
2. Organisational competition with other departments
3. Priorities determination
4. Charge-back method of payment for services
5. Relationship with staff
6. Communication with staff
7. Technical competence of staff
8. Attitude of staff
9. Schedule of products and services
10. Time required for new development
11. Processing of change requests
12. Vendor support
13. Response/turnaround time
14. Means of input/output
15. Convenience of access
16. Accuracy
17. Timeliness
18. Precision
19. Reliability
20. Currency
21. Completeness
22. Input format
23. Language
24. Output volume
25. Relevancy
26. Error recovery
27. Data Security
28. Documentation
29. Expectations
30. Understanding of systems
31. Perceived utility
32. Confidence in systems
33. Feeling of participation
34. Feeling of control
35. Degree of training
36. Job effects
37. Organisational position
38. Flexibility of systems
39. Integration of systems

Appendix 4: Usability Questionnaires

The different types of questionnaires listed below are the ones currently available via the internet:

- **SUMI** – Software Usability Measurement Inventory
- **WAMMI** - Website Analysis and Measurement Inventory
- **SUS** – System Usability Scale
- **QUIS** - Questionnaire for User Interaction Satisfaction
- **CSUQ** – Computer System Usability Questionnaire

These resources are available to download from: www.usabilitynet.org

Appendix 5: Virtual Desktop Questionnaire

Virtual Desktop Survey

This questionnaire has been issued to aid research being undertaken by Andrey Kovalevich at the University Campus Oldham (UCO) for his dissertation. All questionnaires are anonymous; therefore it is appreciated if you could answer as honestly as possible. This research aims to look at the possibility of introducing desktop virtualisation at the UCO for both staff and students. Desktop virtualization will allow you to use any operating systems, e.g. Windows; Linux; Mac OS X; from your own home computer without affecting your home computer. This means that you could access any programs via the University network as if you were actually in the building. Therefore all those expensive programs could be used without having to buy them. It would be free to use and has been known to work faster than a physical computer. There would also be the ability to store all your work on your personal university file, without having to save on external hard drives and physically going into the university to download all your files. However you would need an internet connection as you may get logged out automatically; may not have as high performance as your home computer; do not want to save local copies and may prefer to be at the UCO to work. The questions below are there to investigate these issues, so please think about where on the scale you think you are. This survey will take 5-10 minutes (MAX) to complete so please undertake it in one continuous go answering all questions.

General Information:

Q1: What is your gender? *

- ○ Male
- ○ Female

Q2: Are you: *

- ☐ Student
- ☐ Staff

Q3: What is your age group? *

- ○ 17-20
- ○ 21-29
- ○ 30-39
- ○ 40-49
- ○ Over 50

Q4: What is your educational background *

- ☐ 6th Form College
- ☐ Vocational Training
- ☐ College
- ☐ Bachelor's Degree
- ☐ Master's Degree
- ☐ Doctoral Degree
- ☐ Other: [ ]

Q5: How long have you been at the UCO? *

- ○ 1-3 years
- ○ 3-5 years
- ○ over 5 years

Q6: Do you have access to the internet at home? *

- ○ Yes
- ○ No

Q7: How long have you used the internet? *

- ○ 1-6 month
- ○ 6 month -1 year
- ○ 1-3 years
- ○ 3-5 years
- ○ over 5 years

Q8: What devices do you own / use? *

- ☐ Laptop PC
- ☐ Desktop PC
- ☐ Tablet
- ☐ Smartphone
- ☐ Netbook

- Other:

Q9: What operating system do you use at home? *

- Windows
- Apple Mac OS
- Linux
- Other:

Q10: Do you use your home computer for university course / preparation work? *

- Yes
- No

Q11: How much time is spent on your home computer per week? *

- 1-5 hours
- 5-10 hours
- 10-20 hours
- Over 20 hours

Q12: Do you have easy access to the computers at the UCO? *

- Yes
- No

Q13: Are you able to access the programs you need? *

- Yes
- No

Q14: I have tried to use a virtual desktop before. *

- Yes
- No

Q15: Would you like to be able to use the UCO programs from home? *

- ☐ Windows XP
- ☐ Windows 7
- ☐ Windows 8
- ☐ Access 2010
- ☐ Excel 2010
- ☐ One Note 2010
- ☐ PowerPoint 2010
- ☐ Publisher 2010
- ☐ Project 2010
- ☐ Word 2010
- ☐ SPSS 20
- ☐ Sketchup 8 Pro
- ☐ 3Ds MAX
- ☐ Adobe Flash
- ☐ Adobe Photoshop
- ☐ Adobe Dreamweaver
- ☐ Adobe Illustrator
- ☐ Adobe After Effects
- ☐ EndNote
- ☐ Other: _____

Virtualization:

Please select your response to each of the following questions:

Q16: I am always able to access a computer at UCO *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q17: I enjoy learning new things. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q18: I enjoy the challenge of new technology. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q19: I would be interested in accessing a virtual desktop. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q20: It sounds like a virtual desktop would be too complicated for me to understand. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q21: I need time to trial any new technology prior to its implementation. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q22: I need help from others when new technology is implemented. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q23: IT support is always helpful as their explanations are easy to understand. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q24: I believe that support will be available to deal with any difficulties I have. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q25: I am concerned that a virtual desktop would not be very secure and others would be able to see what I am doing. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q26: Using a virtual desktop would help me better with my university work due to the easy access to the programs I need. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q27: Using a virtual desktop would allow me more time to do my university work as I could spend more time at home. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q28: Working from home would be a calmer / quieter environment to work in *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q29: A virtual desktop would allow me to trial more programs than at present. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q30: A virtual desktop would reduce costs for me as I could work better from home. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q31: I could save money by using the UCO programs via the virtual desktop rather than buying my own copy. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q32: I could save money by using the virtual desktop as my computer wouldn't need to be upgraded. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q33: I would like to be able to use my own technology devices at the UCO. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q34: I would like to be able to print from my own technology devices at the UCO. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q35: I would not need to worry about the UCO being closed during the holidays as I can still work from home. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q36: It would help me greatly being able to access the UCO programs from abroad. *

	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

Q37: I would be very happy to use the UCO virtual desktop *

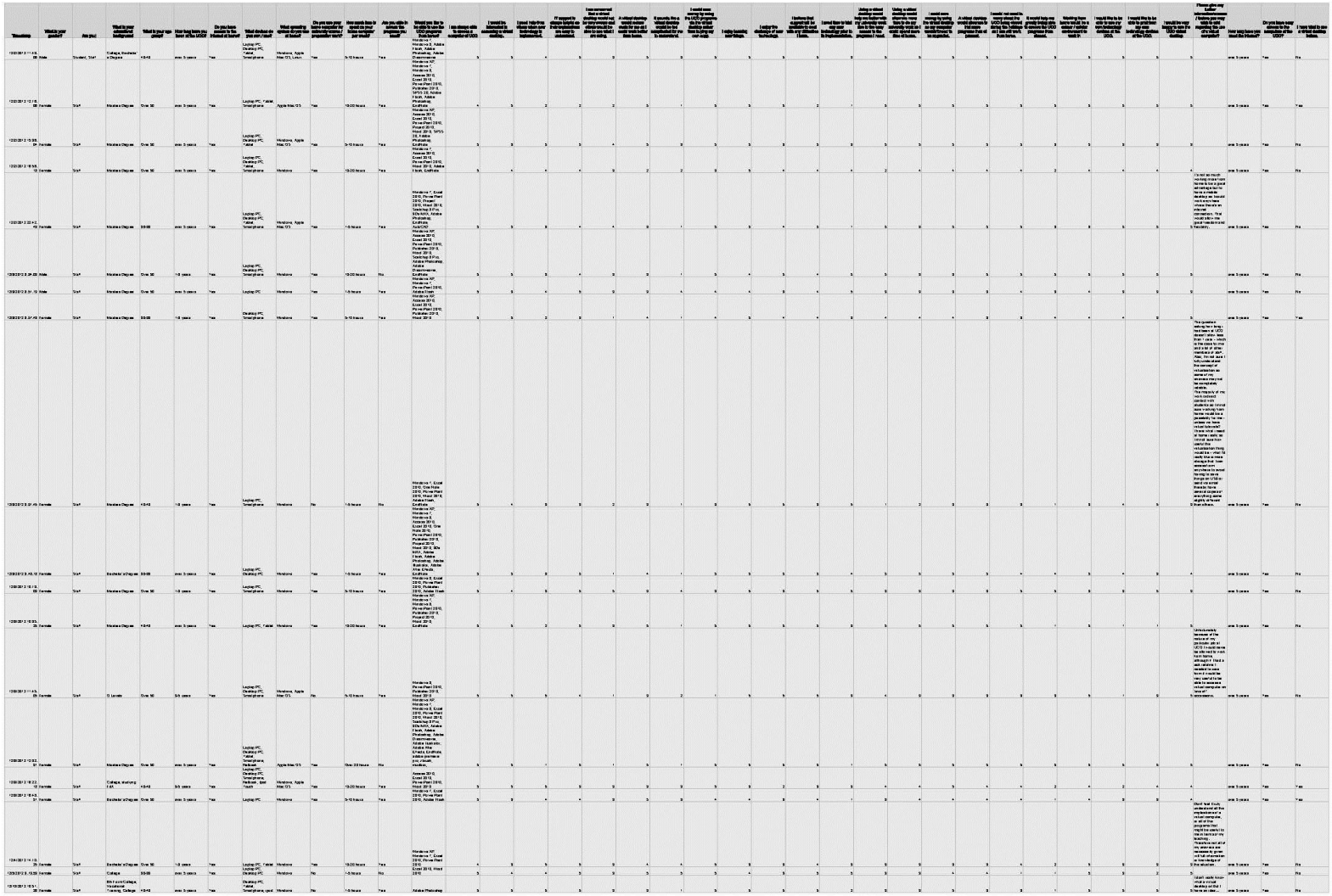
	1	2	3	4	5	
Definitely Not	○	○	○	○	○	Definitely

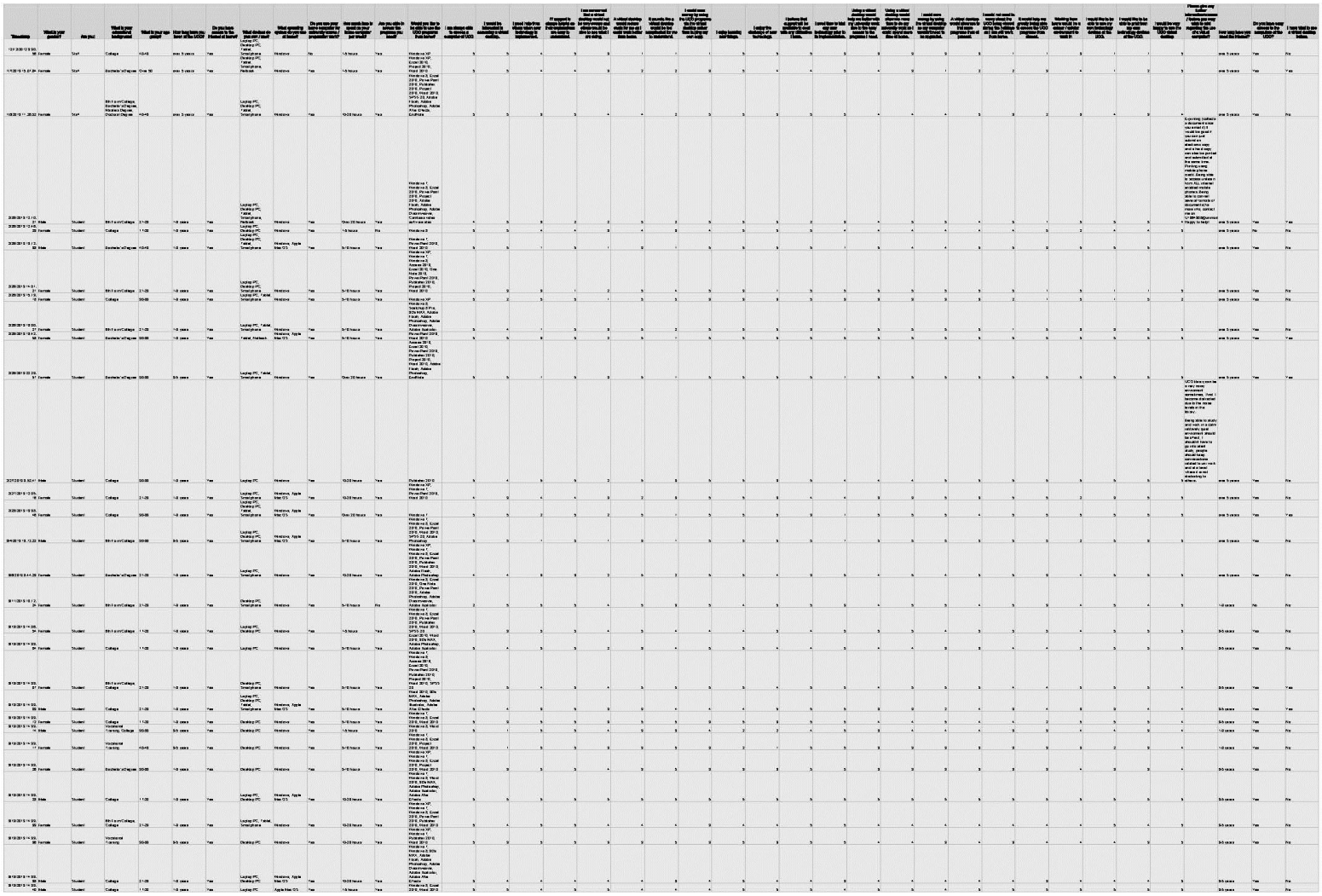
Please give any further information / comments / factors you may wish to add regarding the use of a virtual computer?

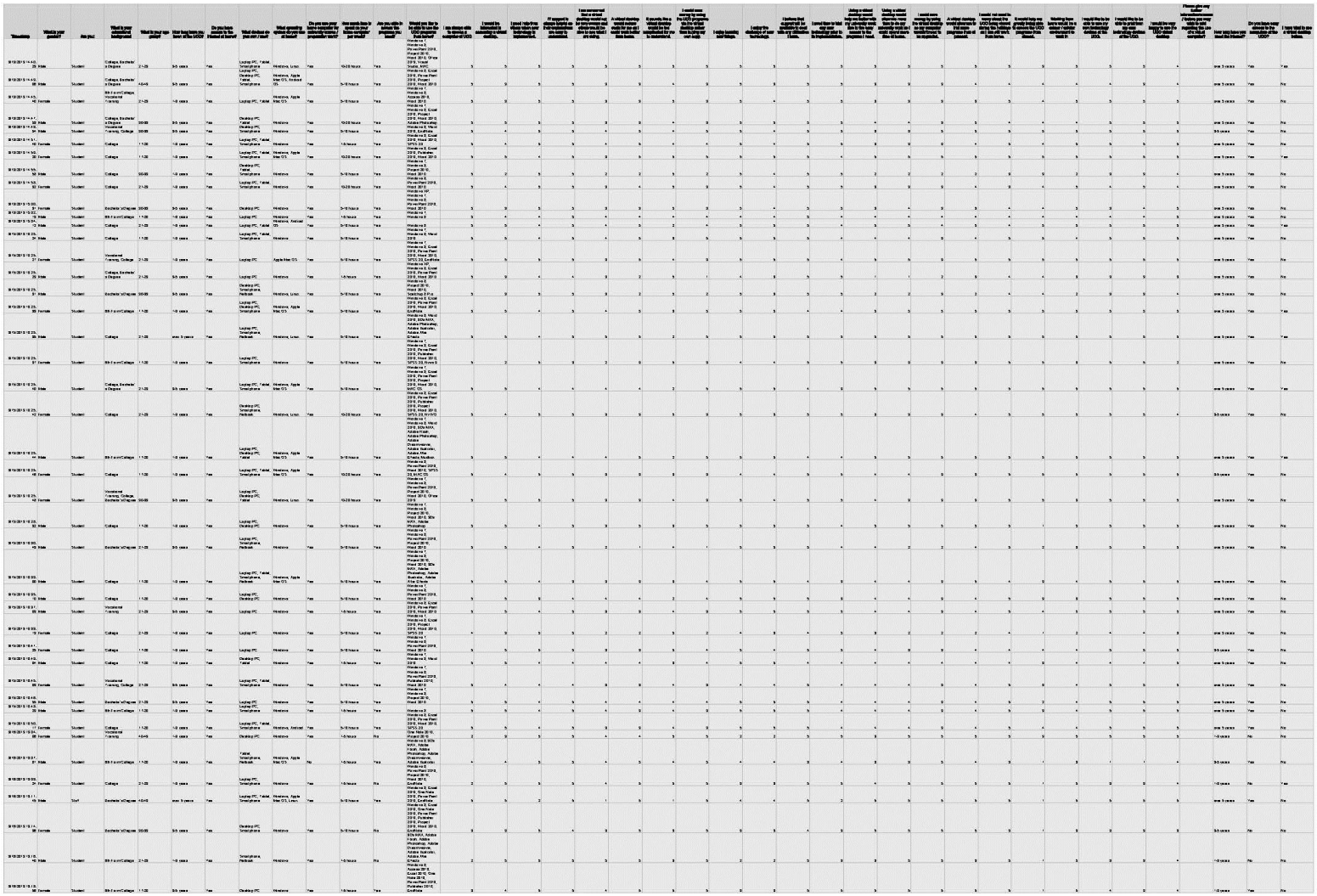
https://docs.google.com/spreadsheet/viewform?formkey=dEVCUVFVT3VjOW5MQWNlUG1oa3FRd3c6MA#gid=0

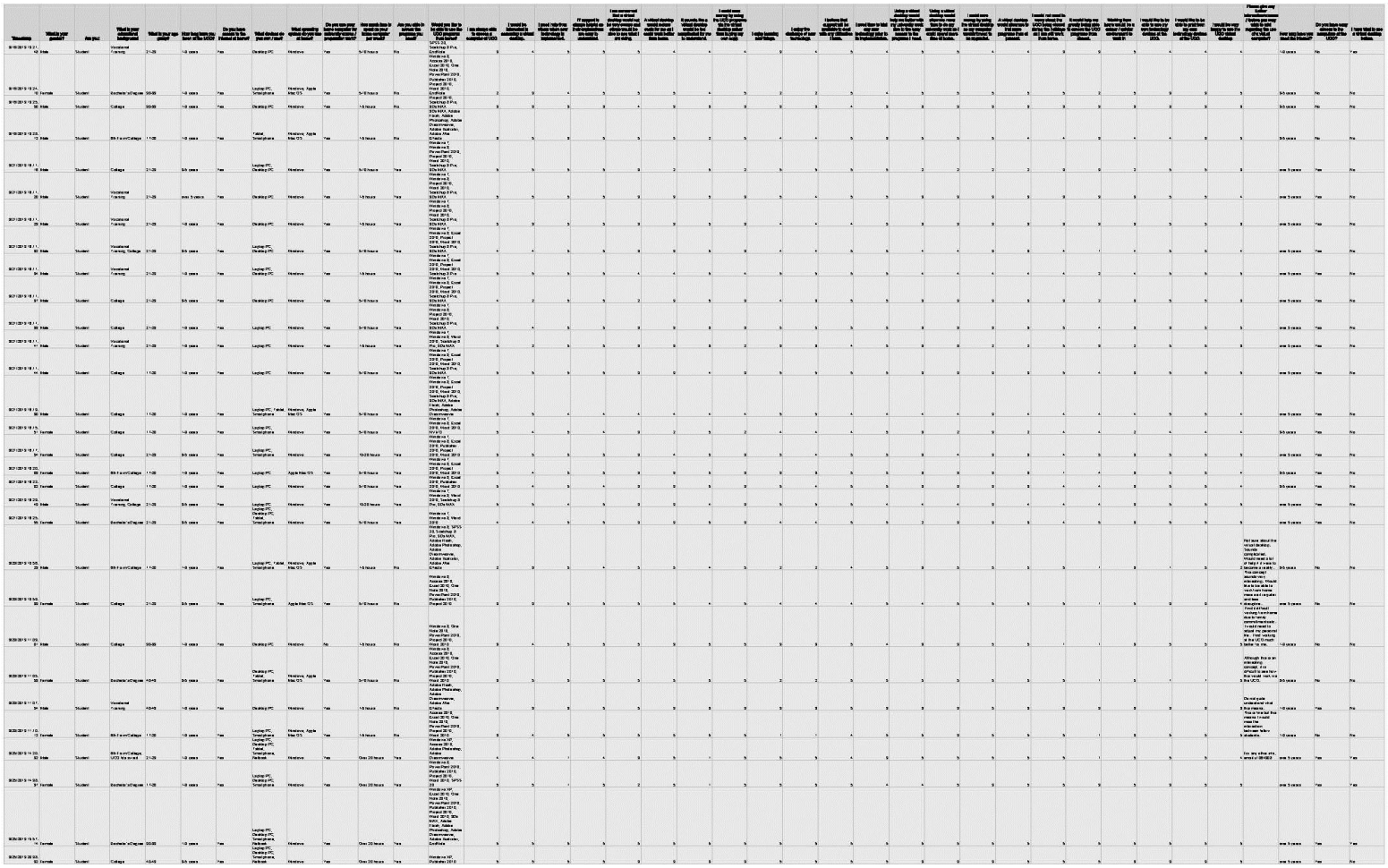
Appendix 6: Virtual Desktop Survey (online answer)

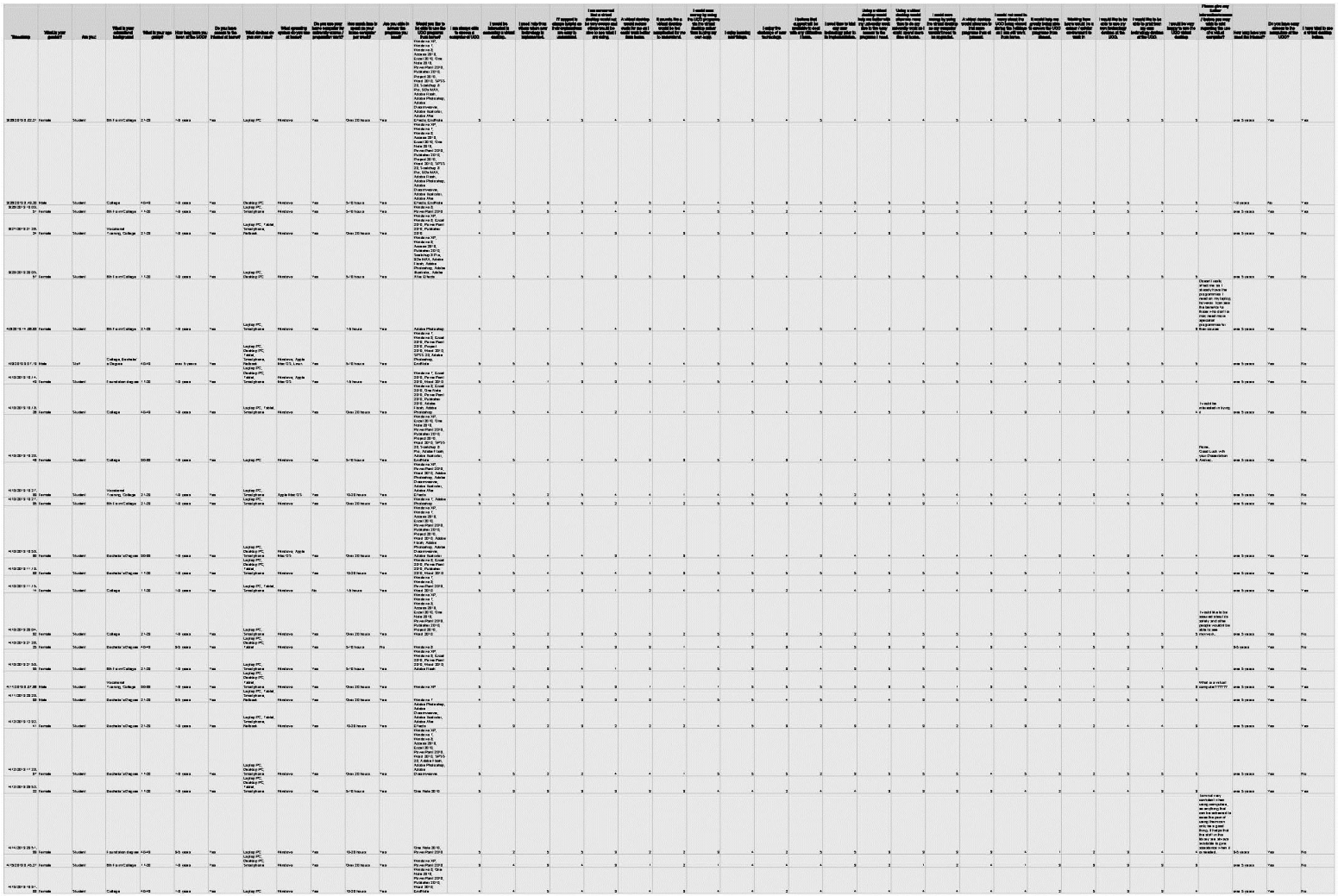
Copy of Virtual Desktop Survey (209) - Sheet1

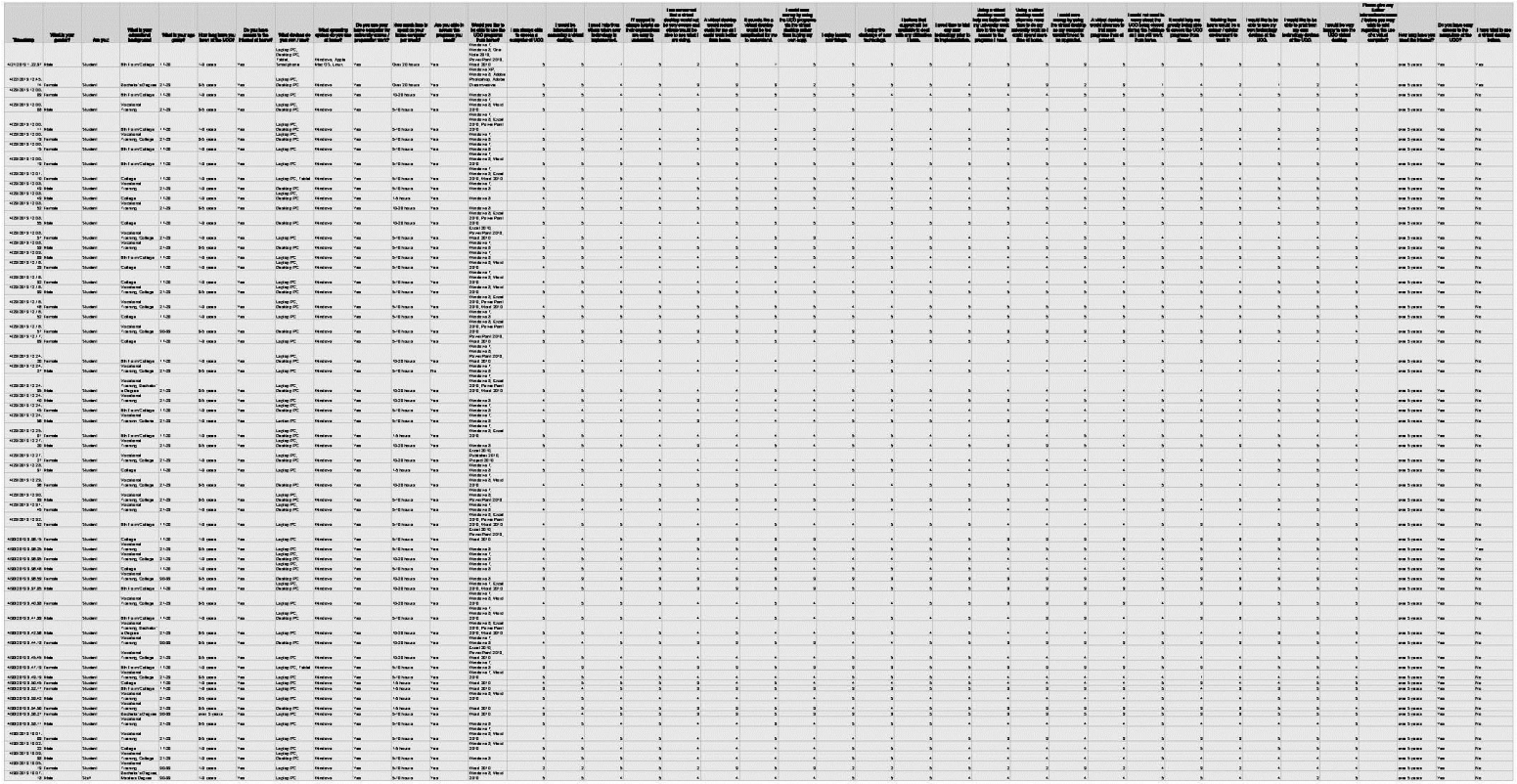










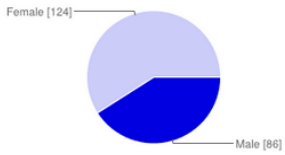


Appendix 7: Virtual Desktop Survey (online graphs)

General Information

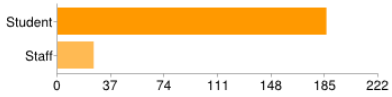
Please select the appropriate answer

What is your gender?



Male	86	41%
Female	124	59%

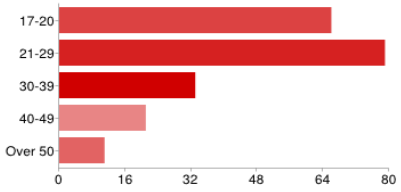
Are you:



Student	186	89%
Staff	25	12%

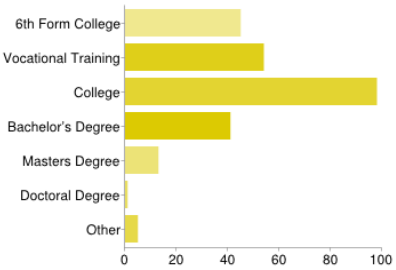
People may select more than one checkbox, so percentages may add up to more than 100%.

What is your age group?



17-20	66	31%
21-29	79	38%
30-39	33	16%
40-49	21	10%
Over 50	11	5%

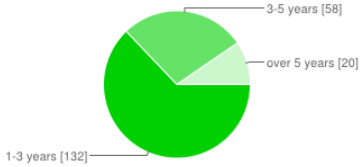
What is your educational background



6th Form College	45	21%
Vocational Training	54	26%
College	98	47%
Bachelor's Degree	41	20%
Masters Degree	13	6%
Doctoral Degree	1	0%
Other	5	2%

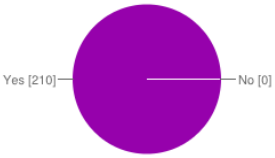
People may select more than one checkbox, so percentages may add up to more than 100%.

How long have you been at the UCO?



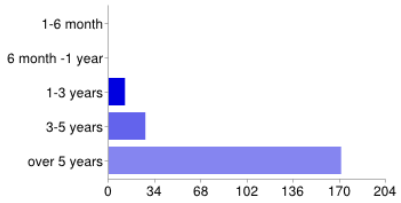
1-3 years	132	63%
3-5 years	58	28%
over 5 years	20	10%

Do you have access to the internet at home?



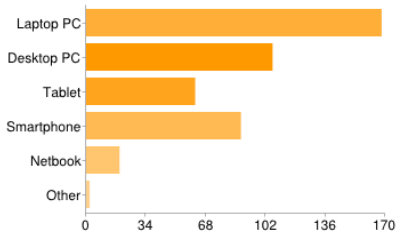
Yes	210	100%
No	0	0%

How long have you used the internet?



1-6 month	**0**	0%
6 month -1 year	**0**	0%
1-3 years	**12**	6%
3-5 years	**27**	13%
over 5 years	**171**	81%

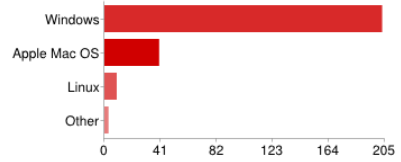
What devices do you own / use?



Laptop PC	**168**	80%
Desktop PC	**106**	50%
Tablet	**62**	30%
Smartphone	**88**	42%
Netbook	**19**	9%
Other	**2**	1%

People may select more than one checkbox, so percentages may add up to more than 100%.

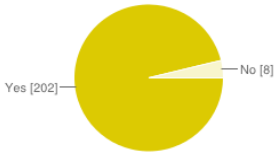
What operating system do you use at home?



Windows	**203**	97%
Apple Mac OS	**40**	19%
Linux	**9**	4%
Other	**3**	1%

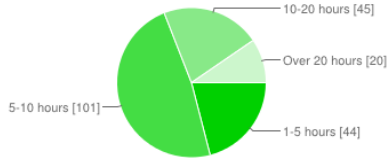
People may select more than one checkbox, so percentages may add up to more than 100%.

Do you use your home computer for university course / preparation work?



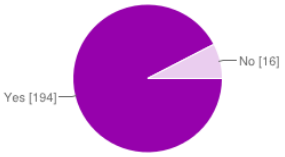
Yes	**202**	96%
No	**8**	4%

How much time is spent on your home computer per week?



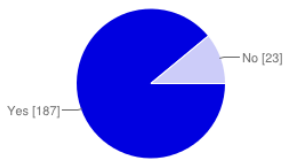
1-5 hours	**44**	21%
5-10 hours	**101**	48%
10-20 hours	**45**	21%
Over 20 hours	**20**	10%

Do you have easy access to the computers at the UCO?



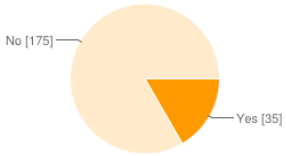
Yes	**194**	92%
No	**16**	8%

Are you able to access the programs you need?



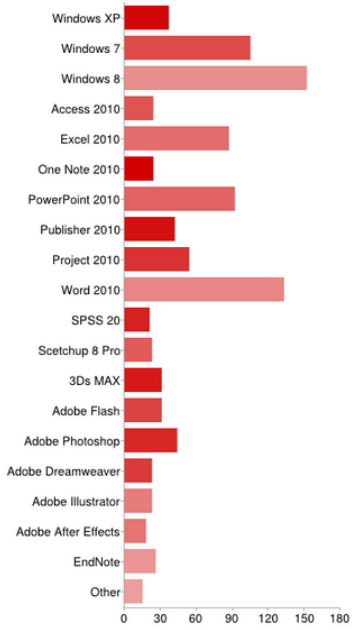
Yes	**187**	89%
No	**23**	11%

I have tried to use a virtual desktop before.



Yes	35	17%
No	175	83%

Would you like to be able to use the UCO programs from home?



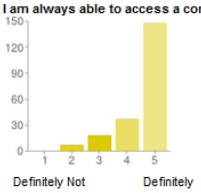
Windows XP	37	18%
Windows 7	105	50%
Windows 8	152	72%
Access 2010	24	11%
Excel 2010	87	41%
One Note 2010	24	11%
PowerPoint 2010	92	44%
Publisher 2010	42	20%
Project 2010	54	26%
Word 2010	133	63%
SPSS 20	21	10%
Scetchup 8 Pro	23	11%
3Ds MAX	31	15%
Adobe Flash	31	15%
Adobe Photoshop	44	21%
Adobe Dreamweaver	23	11%
Adobe Illustrator	23	11%
Adobe After Effects	18	9%
EndNote	26	12%
Other	15	7%

People may select more than one checkbox, so percentages may add up to more than 100%.

Virtualization

Please select your response to each of the following questions:

I am always able to access a computer at UCO

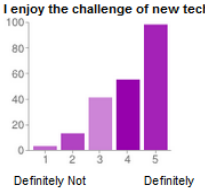


1 - Definitely Not	0	0%
2	7	3%
3	18	9%
4	37	18%
5 - Definitely	148	70%

I enjoy learning new things.

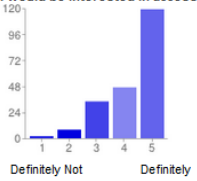
1 - Definitely Not	1	0%
2	8	4%
3	22	10%
4	51	24%
5 - Definitely	128	61%

I enjoy the challenge of new technology.



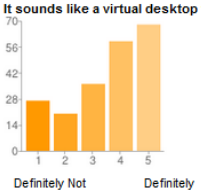
1 -	Definitely Not	3	1%
2		13	6%
3		41	20%
4		55	26%
5 -	Definitely	98	47%

I would be interested in accessing a virtual desktop.



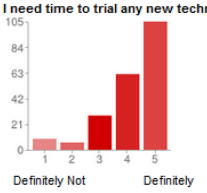
1 -	Definitely Not	2	1%
2		8	4%
3		34	16%
4		47	22%
5 -	Definitely	119	57%

It sounds like a virtual desktop would be too complicated for me to understand.



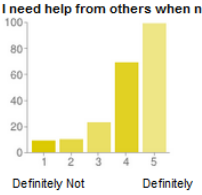
1 -	Definitely Not	27	13%
2		20	10%
3		36	17%
4		59	28%
5 -	Definitely	68	32%

I need time to trial any new technology prior to its implementation.



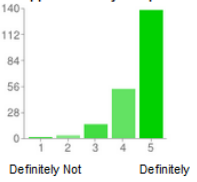
1 -	Definitely Not	9	4%
2		6	3%
3		28	13%
4		62	30%
5 -	Definitely	105	50%

I need help from others when new technology is implemented.



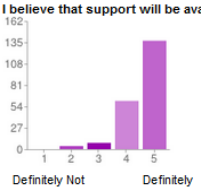
1 -	Definitely Not	9	4%
2		10	5%
3		23	11%
4		69	33%
5 -	Definitely	99	47%

IT support is always helpful as their explanations are easy to understand.



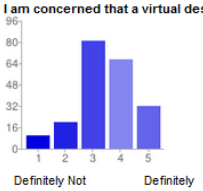
1 -	Definitely Not	1	0%
2		3	1%
3		15	7%
4		53	25%
5 -	Definitely	138	66%

I believe that support will be available to deal with any difficulties I have.



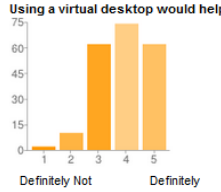
1 -	Definitely Not	0	0%
2		4	2%
3		8	4%
4		61	29%
5 -	Definitely	137	65%

I am concerned that a virtual desktop would not be very secure and others would be able to see what I am doing.



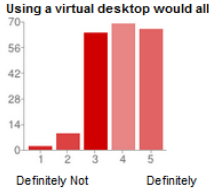
1 -	Definitely Not	10	5%
2		20	10%
3		81	39%
4		67	32%
5 -	Definitely	32	15%

Using a virtual desktop would help me better with my university work due to the easy access to the programs I need.



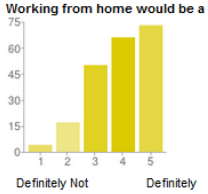
1 -	Definitely Not	2	1%
2		10	5%
3		62	30%
4		74	35%
5 -	Definitely	62	30%

Using a virtual desktop would allow me more time to do my university work as I could spend more time at home.



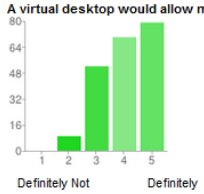
1 -	Definitely Not	2	1%
2		9	4%
3		64	30%
4		69	33%
5 -	Definitely	66	31%

Working from home would be a calmer / quieter environment to work in



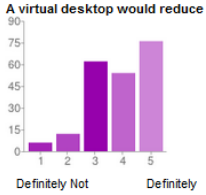
1 -	Definitely Not	4	2%
2		17	8%
3		50	24%
4		66	31%
5 -	Definitely	73	35%

A virtual desktop would allow me to trial more programs than at present.



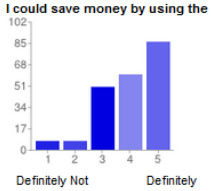
1 -	Definitely Not	0	0%
2		9	4%
3		52	25%
4		70	33%
5 -	Definitely	79	38%

A virtual desktop would reduce costs for me as I could work better from home.



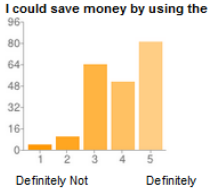
1 -	Definitely Not	6	3%
2		12	6%
3		62	30%
4		54	26%
5 -	Definitely	76	36%

I could save money by using the UCO programs via the virtual desktop rather than buying my own copy.



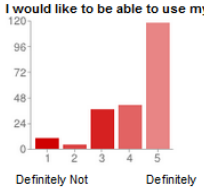
1 -	Definitely Not	7	3%
2		7	3%
3		50	24%
4		60	29%
5 -	Definitely	86	41%

I could save money by using the virtual desktop as my computer wouldn't need to be upgraded.



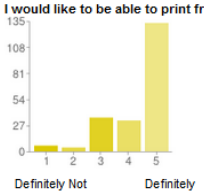
1 - Definitely Not	4	2%
2	10	5%
3	64	30%
4	51	24%
5 - Definitely	81	39%

I would like to be able to use my own technology devices at the UCO.



1 - Definitely Not	10	5%
2	4	2%
3	37	18%
4	41	20%
5 - Definitely	118	56%

I would like to be able to print from my own technology devices at the UCO.

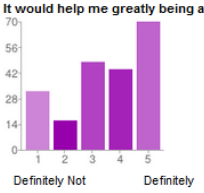


1 - Definitely Not	6	3%
2	4	2%
3	35	17%
4	32	15%
5 - Definitely	133	63%

I would not need to worry about the UCO being closed during the holidays as I can still work from home.

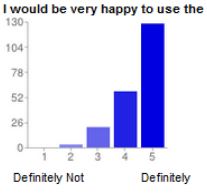
1 - Definitely Not	7	3%
2	3	1%
3	26	12%
4	52	25%
5 - Definitely	122	58%

It would help me greatly being able to access the UCO programs from abroad.



1 - Definitely Not	32	15%
2	16	8%
3	48	23%
4	44	21%
5 - Definitely	70	33%

I would be very happy to use the UCO virtual desktop



1 - Definitely Not	0	0%
2	3	1%
3	21	10%
4	58	28%
5 - Definitely	128	61%

Extra

THANK YOU FOR PARTICIPATING IN THIS RESEARCH Andrey Kovalevich December 2012

https://docs.google.com/spreadsheet/gform?key=0AvdAZVQnPq2TdEVCUVFVT3VjOW5MQWNlUG1oa3FRd3c&gridId=0#chart

Appendix 8: Tables

		Do you have access to the internet at home?	Total
		Yes	
Student	Male	80	80
	Female	104	104
Total		184	184

Table 5: Home Internet Access for Students

		Do you have access to the internet at home?	Total
		Yes	
Staff	Male	6	6
	Female	19	19
Total		25	25

Table 6: Home Internet Access for Staff

		Responses	
		Number?	Percentage?
	Laptop?	167	37.7%
	Desktop?	106	23.9%
	Tablet?	61	13.8%
	Smartphone?	87	19.6%
	Netbook?	20	4.5%
	Other?	2	0.5%
Total		443	100.0%

Table 7: Computer Devices Currently Owned by All Users

	N	Percent	
Windows	202	79.5%	96.7%
Apple OS	40	15.7%	19.1%
Linux	9	3.5%	4.3%
Other	3	1.2%	1.4%
Total	254	100.0%	121.5%

Table 8: Type of Operating System Used

		Do you use your home computer for university course / preparation work?		Total
		Yes	No	
What is your gender (Staff)?	Male	6	0	6
		100.0%	0.0%	100.0%
	Female	14	5	19
		73.7%	26.3%	100.0%
Total		20	5	25
		80.0%	20.0%	100.0%

Table 9: Use of Home Computer for UCO Work/Study (Staff)

		Do you use your home computer for university course / preparation work?		Total
		Yes	No	
What is your gender (Student)?	Male	78	2	80
		97.5%	2.5%	100.0%
	Female	103	1	104
		99.0%	1.0%	100.0%
Total		181	3	184
		98.4%	1.6%	100.0%

Table 10: Use of Home Computer for UCO Work/Study (Students)

		How much time is spent on your home computer per week (Student)?				Total
		1-5 hours	5-10 hours	10-20 hours	Over 20 hours	
What is your age group (Student)?	17-20	20	35	8	4	67
		29.9%	52.2%	11.9%	6.0%	100.0%
	21-29	11	37	21	8	77
		14.3%	48.1%	27.3%	10.4%	100.0%
	30-39	3	14	6	5	28
		10.7%	50.0%	21.4%	17.9%	100.0%
	40-49	2	6	2	2	12
		16.7%	50.0%	16.7%	16.7%	100.0%
Total		36	92	37	19	184
		19.6%	50.0%	20.1%	10.3%	100.0%

Table 11: Time Spent On Course Work per Week on the Computer (Students)

		How much time is spent on your home computer per week (Staff)?				Total
		1-5 hours	5-10 hours	10-20 hours	Over 20 hours	
What is your age group (Staff)?	30-39	3	1	0	0	4
		75.0%	25.0%	0.0%	0.0%	100.0%
	40-49	2	4	3	0	9
		22.2%	44.4%	33.3%	0.0%	100.0%
	Over 50	3	4	4	1	12
		25.0%	33.3%	33.3%	8.3%	100.0%
Total		8	9	7	1	25
		32.0%	36.0%	28.0%	4.0%	100.0%

Table 12: Time Spent On Course Work per Week on the Computer (Staff)

		I have tried to use a virtual desktop before (Student).		Total
		Yes	No	
What is your gender (Student)?	Male	13	67	80
		16.2%	83.8%	100.0%
	Female	17	87	104
		16.3%	83.7%	100.0%
Total		30	154	184
		16.3%	83.7%	100.0%

Table 13: Previous Use of a Virtual Desktop (Students)

			I have tried to use a virtual desktop before (Staff).		Total
			Yes	No	
What is your gender (Staff)?	Male		0	6	6
			0.0%	100.0%	100.0%
	Female		5	14	19
			26.3%	73.7%	100.0%
Total			5	20	25
			20.0%	80.0%	100.0%

Table 14: Previous Use of a Virtual Desktop (Staff)

Would you like to be able to use the UCO programs from home?

	Responses		Percent of Cases
	N	Percent	
Windows XP?	36	3.6%	17.2%
Windows 7?	104	10.5%	49.8%
Windows 8?	151	15.2%	72.2%
Access 2010?	23	2.3%	11.0%
Excel 2010?	86	8.7%	41.1%
OneNote 2010?	23	2.3%	11.0%
Power Point 2010?	91	9.2%	43.5%
Publisher 2010?	40	4.0%	19.1%
Project 2010?	55	5.5%	26.3%
Word 2010?	133	13.4%	63.6%
SPSS 20?	20	2.0%	9.6%
Scetchup 8 Pro?	22	2.2%	10.5%
3Ds MAX?	31	3.1%	14.8%
Flash?	31	3.1%	14.8%
Photoshop?	44	4.4%	21.1%
Dreamweaver?	23	2.3%	11.0%
Illustartor?	23	2.3%	11.0%
After Effects?	19	1.9%	9.1%
EndNote?	26	2.6%	12.4%
Other?	11	1.1%	5.3%
Total	992	100.0%	474.6%

Table 15: Most Popular Programs of Choice by All Users

		I enjoy the challenge of new technology					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student)?	17-20	1	4	5	19	38	67
		1.5%	6.0%	7.5%	28.4%	56.7%	100.0%
	21-29	1	1	13	24	38	77
		1.3%	1.3%	16.9%	31.2%	49.4%	100.0%
	30-39	0	3	12	6	7	28
		0.0%	10.7%	42.9%	21.4%	25.0%	100.0%
	40-49	1	4	4	1	2	12
		8.3%	33.3%	33.3%	8.3%	16.7%	100.0%
Total		3	12	34	50	85	184
		1.6%	6.5%	18.5%	27.2%	46.2%	100.0%

Table 16: Challenge of New Technology for Students

		I enjoy the challenge of new technology				Total
		Unlikely	Neutral	Possible	Definitely	
What is your age group (Staff)?	30-39	0	1	2	1	4
		0.0%	25.0%	50.0%	25.0%	100.0%
	40-49	1	0	1	7	9
		11.1%	0.0%	11.1%	77.8%	100.0%
	Over 50	0	5	2	5	12
		0.0%	41.7%	16.7%	41.7%	100.0%
Total		1	6	5	13	25
		4.0%	24.0%	20.0%	52.0%	100.0%

Table 17: Challenge of New Technology for Staff

		I enjoy the challenge of new technology					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Female)?	17-20	1	3	5	14	19	42
		2.4%	7.1%	11.9%	33.3%	45.2%	100.0%
	21-29	1	0	10	18	7	36
		2.8%	0.0%	27.8%	50.0%	19.4%	100.0%
	30-39	0	2	8	4	4	18
		0.0%	11.1%	44.4%	22.2%	22.2%	100.0%
	40-49	1	4	1	1	1	8
		12.5%	50.0%	12.5%	12.5%	12.5%	100.0%
Total		3	9	24	37	31	104
		2.9%	8.7%	23.1%	35.6%	29.8%	100.0%

Table 18: Challenge of New Technology for Female Students

		I enjoy the challenge of new technology				Total
		Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Male)?	17-20	1	0	5	19	25
		4.0%	0.0%	20.0%	76.0%	100.0%
	21-29	1	3	6	31	41
		2.4%	7.3%	14.6%	75.6%	100.0%
	30-39	1	4	2	3	10
		10.0%	40.0%	20.0%	30.0%	100.0%
	40-49	0	3	0	1	4
		0.0%	75.0%	0.0%	25.0%	100.0%
Total		3	10	13	54	80
		3.8%	12.5%	16.2%	67.5%	100.0%

Table 19: Challenge of New Technology for Male Students

		I enjoy the challenge of new technology				Total
		Unlikely	Neutral	Possible	Definitely	
What is your age group (Staff Female)?	30-39	0	1	2	1	4
		0.0%	25.0%	50.0%	25.0%	100.0%
	40-49	1	0	0	4	5
		20.0%	0.0%	0.0%	80.0%	100.0%
	Over 50	0	4	2	4	10
		0.0%	40.0%	20.0%	40.0%	100.0%
Total		1	5	4	9	19
		5.3%	26.3%	21.1%	47.4%	100.0%

Table 20: Challenge of New Technology for Female Staff

		I enjoy the challenge of new technology			Total
		Neutral	Possible	Definitely	
What is your age group (Staff Male)?	40-49	0	1	3	4
		0.0%	25.0%	75.0%	100.0%
	Over 50	1	0	1	2
		50.0%	0.0%	50.0%	100.0%
Total		1	1	4	6
		16.7%	16.7%	66.7%	100.0%

Table 21: Challenge of New Technology for Male Staff

		It sounds like a virtual desktop would be too complicated for me to understand					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Female)?	17-20	3	1	7	13	18	42
		7.1%	2.4%	16.7%	31.0%	42.9%	100.0%
	21-29	2	5	5	9	15	36
		5.6%	13.9%	13.9%	25.0%	41.7%	100.0%
	30-39	3	0	4	2	9	18
		16.7%	0.0%	22.2%	11.1%	50.0%	100.0%
	40-49	2	1	2	0	3	8
		25.0%	12.5%	25.0%	0.0%	37.5%	100.0%
Total		10	7	18	24	45	104
		9.6%	6.7%	17.3%	23.1%	43.3%	100.0%

Table 22: Is a Virtual Desktop Too Complicated for Female Students to Understand?

		It sounds like a virtual desktop would be too complicated for me to understand					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Male)?	17-20	1	3	4	12	5	25
		4.0%	12.0%	16.0%	48.0%	20.0%	100.0%
	21-29	2	4	6	15	14	41
		4.9%	9.8%	14.6%	36.6%	34.1%	100.0%
	30-39	2	0	3	2	3	10
		20.0%	0.0%	30.0%	20.0%	30.0%	100.0%
	40-49	1	1	1	1	0	4
		25.0%	25.0%	25.0%	25.0%	0.0%	100.0%
Total		6	8	14	30	22	80
		7.5%	10.0%	17.5%	37.5%	27.5%	100.0%

Table 23: Is a Virtual Desktop Too Complicated for Male Students to Understand?

		It sounds like a virtual desktop would be too complicated for me to understand					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Staff Female)?	30-39	3	0	0	0	1	4
		75.0%	0.0%	0.0%	0.0%	25.0%	100.0%
	40-49	3	1	1	0	0	5
		60.0%	20.0%	20.0%	0.0%	0.0%	100.0%
	Over 50	3	3	2	2	0	10
		30.0%	30.0%	20.0%	20.0%	0.0%	100.0%
Total		9	4	3	2	1	19
		47.4%	21.1%	15.8%	10.5%	5.3%	100.0%

Table 24: Is a Virtual Desktop Too Complicated for Female Staff to Understand?

		It sounds like a virtual desktop would be too complicated for me to understand			Total
		Definitely Not	Neutral	Possible	
What is your age group (Staff Male)?	40-49	1	1	2	4
		25.0%	25.0%	50.0%	100.0%
	Over 50	1	0	1	2
		50.0%	0.0%	50.0%	100.0%
Total		2	1	3	6
		33.3%	16.7%	50.0%	100.0%

Table 25: Is a Virtual Desktop Too Complicated for Male Staff to Understand?

		I need help from others when new technology is implemented					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Male)?	17-20	1	0	2	16	6	25
		4.0%	0.0%	8.0%	64.0%	24.0%	100.0%
	21-29	1	1	2	18	19	41
		2.4%	2.4%	4.9%	43.9%	46.3%	100.0%
	30-39	1	0	1	0	8	10
		10.0%	0.0%	10.0%	0.0%	80.0%	100.0%
	40-49	1	0	2	0	1	4
		25.0%	0.0%	50.0%	0.0%	25.0%	100.0%
Total		4	1	7	34	34	80
		5.0%	1.2%	8.8%	42.5%	42.5%	100.0%

Table 26: Help Required for Male Students on Implementation of New Technology

			I need help from others when new technology is implemented					Total
			Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Female)?	17-20		2	1	2	14	23	42
			4.8%	2.4%	4.8%	33.3%	54.8%	100.0%
	21-29		1	3	5	9	18	36
			2.8%	8.3%	13.9%	25.0%	50.0%	100.0%
	30-39		1	1	2	3	11	18
			5.6%	5.6%	11.1%	16.7%	61.1%	100.0%
	40-49		1	0	0	1	6	8
			12.5%	0.0%	0.0%	12.5%	75.0%	100.0%
Total			5	5	9	27	58	104
			4.8%	4.8%	8.7%	26.0%	55.8%	100.0%

Table 27: Help Required for Female Students on Implementation of New Technology

		I need help from others when new technology is implemented					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Staff Female)?	30-39	0	1	2	1	0	4
		0.0%	25.0%	50.0%	25.0%	0.0%	100.0%
	40-49	0	1	1	1	2	5
		0.0%	20.0%	20.0%	20.0%	40.0%	100.0%
	Over 50	1	1	2	3	3	10
		10.0%	10.0%	20.0%	30.0%	30.0%	100.0%
Total		1	3	5	5	5	19
		5.3%	15.8%	26.3%	26.3%	26.3%	100.0%

Table 28: Help Required for Female Staff on Implementation of New Technology

		I need help from others when new technology is implemented				Total
		Unlikely	Neutral	Possible	Definitely	
What is your age group (Staff Male)?	40-49	1	0	2	1	4
		25.0%	0.0%	50.0%	25.0%	100.0%
	Over 50	0	1	1	0	2
		0.0%	50.0%	50.0%	0.0%	100.0%
Total		1	1	3	1	6
		16.7%	16.7%	50.0%	16.7%	100.0%

Table 29: Help Required for Male Staff on Implementation of New Technology

		I am concerned that a virtual desktop would not be very secure and others would be able to see what I am doing					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Female)?	17-20	1	3	18	16	4	42
		2.4%	7.1%	42.9%	38.1%	9.5%	100.0%
	21-29	1	5	11	13	6	36
		2.8%	13.9%	30.6%	36.1%	16.7%	100.0%
	30-39	1	3	10	1	3	18
		5.6%	16.7%	55.6%	5.6%	16.7%	100.0%
	40-49	0	1	5	1	1	8
		0.0%	12.5%	62.5%	12.5%	12.5%	100.0%
Total		3	12	44	31	14	104
		2.9%	11.5%	42.3%	29.8%	13.5%	100.0%

Table 30: Security of the Female Students' Virtual Desktop

		I am concerned that a virtual desktop would not be very secure and others would be able to see what I am doing					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Male)?	17-20	0	1	4	16	4	25
		0.0%	4.0%	16.0%	64.0%	16.0%	100.0%
	21-29	0	3	15	13	10	41
		0.0%	7.3%	36.6%	31.7%	24.4%	100.0%
	30-39	1	2	3	3	1	10
		10.0%	20.0%	30.0%	30.0%	10.0%	100.0%
	40-49	1	0	2	0	1	4
		25.0%	0.0%	50.0%	0.0%	25.0%	100.0%
Total		2	6	24	32	16	80
		2.5%	7.5%	30.0%	40.0%	20.0%	100.0%

Table 31: Security of the Male Students' Virtual Desktop

		I am concerned that a virtual desktop would not be very secure and others would be able to see what I am doing					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Staff Female)?	30-39	2	0	1	1	0	4
		50.0%	0.0%	25.0%	25.0%	0.0%	100.0%
	40-49	0	0	4	1	0	5
		0.0%	0.0%	80.0%	20.0%	0.0%	100.0%
	Over 50	2	2	4	1	1	10
		20.0%	20.0%	40.0%	10.0%	10.0%	100.0%
Total		4	2	9	3	1	19
		21.1%	10.5%	47.4%	15.8%	5.3%	100.0%

Table 32: Security of the Female Staffs' Virtual Desktop

		I am concerned that a virtual desktop would not be very secure and others would be able to see what I am doing				Total
		Definitely Not	Neutral	Possible	Definitely	
What is your age group (Staff Male)?	40-49	1	1	1	1	4
		25.0%	25.0%	25.0%	25.0%	100.0%
	Over 50	0	2	0	0	2
		0.0%	100.0%	0.0%	0.0%	100.0%
Total		1	3	1	1	6
		16.7%	50.0%	16.7%	16.7%	100.0%

Table 33: Security of the Male Staffs' Virtual Desktop

		Using a virtual desktop would help me better with my university work due to the easy access to the programs I need					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Male)?	17-20	0	0	4	14	7	25
		0.0%	0.0%	16.0%	56.0%	28.0%	100.0%
	21-29	1	1	10	17	12	41
		2.4%	2.4%	24.4%	41.5%	29.3%	100.0%
	30-39	0	2	5	2	1	10
		0.0%	20.0%	50.0%	20.0%	10.0%	100.0%
	40-49	0	0	2	0	2	4
		0.0%	0.0%	50.0%	0.0%	50.0%	100.0%
Total		1	3	21	33	22	80
		1.2%	3.8%	26.2%	41.2%	27.5%	100.0%

Table 34: Male Students' Easy Access to Programs Using a Virtual Desktop

			Using a virtual desktop would help me better with my university work due to the easy access to the programs I need				Total
			Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Female)?	17-20		2	10	17	13	42
			4.8%	23.8%	40.5%	31.0%	100.0%
	21-29		3	12	12	9	36
			8.3%	33.3%	33.3%	25.0%	100.0%
	30-39		1	7	4	6	18
			5.6%	38.9%	22.2%	33.3%	100.0%
	40-49		0	5	1	2	8
			0.0%	62.5%	12.5%	25.0%	100.0%
Total			6	34	34	30	104
			5.8%	32.7%	32.7%	28.8%	100.0%

Table 35: Female Students' Easy Access to Programs Using a Virtual Desktop

		Using a virtual desktop would help me better with my university work due to the easy access to the programs I need					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Staff Female)?	30-39	0	0	1	1	2	4
		0.0%	0.0%	25.0%	25.0%	50.0%	100.0%
	40-49	0	0	2	2	1	5
		0.0%	0.0%	40.0%	40.0%	20.0%	100.0%
	Over 50	1	1	3	2	3	10
		10.0%	10.0%	30.0%	20.0%	30.0%	100.0%
Total		1	1	6	5	6	19
		5.3%	5.3%	31.6%	26.3%	31.6%	100.0%

Table 36: Female Staffs' Easy Access to Programs Using a Virtual Desktop

		Using a virtual desktop would help me better with my university work due to the easy access to the programs I need			Total
		Neutral	Possible	Definitely	
What is your age group (Staff Male)?	40-49	0	2	2	4
		0.0%	50.0%	50.0%	100.0%
	Over 50	1	0	1	2
		50.0%	0.0%	50.0%	100.0%
Total		1	2	3	6
		16.7%	33.3%	50.0%	100.0%

Table 37: Male Staffs' Easy Access to Programs Using a Virtual Desktop

		Using a virtual desktop would allow me more time to do my university work as I could spend more time at home					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Male)?	17-20	0	0	4	14	7	25
		0.0%	0.0%	16.0%	56.0%	28.0%	100.0%
	21-29	1	2	9	15	14	41
		2.4%	4.9%	22.0%	36.6%	34.1%	100.0%
	30-39	0	2	3	3	2	10
		0.0%	20.0%	30.0%	30.0%	20.0%	100.0%
	40-49	0	0	2	1	1	4
		0.0%	0.0%	50.0%	25.0%	25.0%	100.0%
Total		1	4	18	33	24	80
		1.2%	5.0%	22.5%	41.2%	30.0%	100.0%

Table 38: Male Students Having Extra Time At Home Using a Virtual Desktop

		Using a virtual desktop would allow me more time to do my university work as I could spend more time at home					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Female)?	17-20	1	1	11	16	13	42
		2.4%	2.4%	26.2%	38.1%	31.0%	100.0%
	21-29	0	2	12	9	13	36
		0.0%	5.6%	33.3%	25.0%	36.1%	100.0%
	30-39	0	1	7	3	7	18
		0.0%	5.6%	38.9%	16.7%	38.9%	100.0%
	40-49	0	0	5	1	2	8
		0.0%	0.0%	62.5%	12.5%	25.0%	100.0%
Total		1	4	35	29	35	104
		1.0%	3.8%	33.7%	27.9%	33.7%	100.0%

Table 39: Female Students Having Extra Time At Home Using a Virtual Desktop

		Using a virtual desktop would allow me more time to do my university work as I could spend more time at home				Total
		Unlikely	Neutral	Possible	Definitely	
What is your age group (Staff Female)?	30-39	0	2	1	1	4
		0.0%	50.0%	25.0%	25.0%	100.0%
	40-49	0	2	2	1	5
		0.0%	40.0%	40.0%	20.0%	100.0%
	Over 50	1	4	2	3	10
		10.0%	40.0%	20.0%	30.0%	100.0%
Total		1	8	5	5	19
		5.3%	42.1%	26.3%	26.3%	100.0%

Table 40: Female Staff Having Extra Time At Home Using a Virtual Desktop

		Using a virtual desktop would allow me more time to do my university work as I could spend more time at home			Total
		Neutral	Possible	Definitely	
What is your age group (Staff Male)?	40-49	0	2	2	4
		0.0%	50.0%	50.0%	100.0%
	Over 50	2	0	0	2
		100.0%	0.0%	0.0%	100.0%
Total		2	2	2	6
		33.3%	33.3%	33.3%	100.0%

Table 41: Male Staff Having Extra Time At Home Using a Virtual Desktop

		A virtual desktop would reduce costs for me as I could work better from home					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Female)?	17-20	1	2	12	10	17	42
		2.4%	4.8%	28.6%	23.8%	40.5%	100.0%
	21-29	1	3	7	11	14	36
		2.8%	8.3%	19.4%	30.6%	38.9%	100.0%
	30-39	0	0	10	1	7	18
		0.0%	0.0%	55.6%	5.6%	38.9%	100.0%
	40-49	1	1	3	2	1	8
		12.5%	12.5%	37.5%	25.0%	12.5%	100.0%
Total		3	6	32	24	39	104
		2.9%	5.8%	30.8%	23.1%	37.5%	100.0%

Table 42: Reducing Costs for Female Students by Working from Home

		A virtual desktop would reduce costs for me as I could work better from home					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Male)?	17-20	0	0	4	9	12	25
		0.0%	0.0%	16.0%	36.0%	48.0%	100.0%
	21-29	1	2	10	15	13	41
		2.4%	4.9%	24.4%	36.6%	31.7%	100.0%
	30-39	1	2	5	0	2	10
		10.0%	20.0%	50.0%	0.0%	20.0%	100.0%
	40-49	0	0	3	0	1	4
		0.0%	0.0%	75.0%	0.0%	25.0%	100.0%
Total		2	4	22	24	28	80
		2.5%	5.0%	27.5%	30.0%	35.0%	100.0%

Table 43: Reducing Costs for Male Students by Working from Home

		A virtual desktop would reduce costs for me as I could work better from home					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Staff Female)?	30-39	0	0	1	2	1	4
		0.0%	0.0%	25.0%	50.0%	25.0%	100.0%
	40-49	1	0	2	1	1	5
		20.0%	0.0%	40.0%	20.0%	20.0%	100.0%
	Over 50	0	2	3	1	4	10
		0.0%	20.0%	30.0%	10.0%	40.0%	100.0%
Total		1	2	6	4	6	19
		5.3%	10.5%	31.6%	21.1%	31.6%	100.0%

Table 44: Reducing Costs for Female Staff by Working from Home

		A virtual desktop would reduce costs for me as I could work better from home			Total
		Neutral	Possible	Definitely	
What is your age group (Staff Male)?	40-49	0	2	2	4
		0.0%	50.0%	50.0%	100.0%
	Over 50	2	0	0	2
		100.0%	0.0%	0.0%	100.0%
Total		2	2	2	6
		33.3%	33.3%	33.3%	100.0%

Table 45: Reducing Costs for Male Staff by Working from Home

		I could save money by using the UCO programs via the virtual desktop rather than buying my own copy					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Male)?	17-20	0	0	3	10	12	25
		0.0%	0.0%	12.0%	40.0%	48.0%	100.0%
	21-29	2	2	7	17	13	41
		4.9%	4.9%	17.1%	41.5%	31.7%	100.0%
	30-39	1	2	2	1	4	10
		10.0%	20.0%	20.0%	10.0%	40.0%	100.0%
	40-49	0	0	2	1	1	4
		0.0%	0.0%	50.0%	25.0%	25.0%	100.0%
Total		3	4	14	29	30	80
		3.8%	5.0%	17.5%	36.2%	37.5%	100.0%

Table 46: Benefits of Virtual Programs Compared to Own Copy for Male Students

		I could save money by using the UCO programs via the virtual desktop rather than buying my own copy					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Female)?	17-20	1	1	10	14	16	42
		2.4%	2.4%	23.8%	33.3%	38.1%	100.0%
	21-29	0	2	9	10	15	36
		0.0%	5.6%	25.0%	27.8%	41.7%	100.0%
	30-39	0	0	10	1	7	18
		0.0%	0.0%	55.6%	5.6%	38.9%	100.0%
	40-49	1	0	3	2	2	8
		12.5%	0.0%	37.5%	25.0%	25.0%	100.0%
Total		2	3	32	27	40	104
		1.9%	2.9%	30.8%	26.0%	38.5%	100.0%

Table 47: Benefits of Virtual Programs Compared to Own Copy for Female Students

		I could save money by using the UCO programs via the virtual desktop rather than buying my own copy				Total
		Definitely Not	Neutral	Possible	Definitely	
What is your age group (Staff Female)?	30-39	0	0	1	3	4
		0.0%	0.0%	25.0%	75.0%	100.0%
	40-49	1	0	0	4	5
		20.0%	0.0%	0.0%	80.0%	100.0%
	Over 50	1	4	1	4	10
		10.0%	40.0%	10.0%	40.0%	100.0%
Total		2	4	2	11	19
		10.5%	21.1%	10.5%	57.9%	100.0%

Table 48: Benefits of Virtual Programs Compared to Own Copy for Female Staff

		I could save money by using the UCO programs via the virtual desktop rather than buying my own copy		Total
		Possible	Definitely	
What is your age group (Staff Male)?	40-49	1	3	4
		25.0%	75.0%	100.0%
	Over 50	1	1	2
		50.0%	50.0%	100.0%
Total		2	4	6
		33.3%	66.7%	100.0%

Table 49: Benefits of Virtual Programs Compared to Own Copy for Male Staff

		I could save money by using the virtual desktop as my computer wouldn't need to be upgraded					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Male)?	17-20	0	0	9	6	10	25
		0.0%	0.0%	36.0%	24.0%	40.0%	100.0%
	21-29	0	5	8	14	14	41
		0.0%	12.2%	19.5%	34.1%	34.1%	100.0%
	30-39	1	1	3	1	4	10
		10.0%	10.0%	30.0%	10.0%	40.0%	100.0%
	40-49	0	0	1	1	2	4
		0.0%	0.0%	25.0%	25.0%	50.0%	100.0%
Total		1	6	21	22	30	80
		1.2%	7.5%	26.2%	27.5%	37.5%	100.0%

Table 50: Benefits of not having to Upgrade Own Computer by Using a Virtual Desktop for Male Students

		I could save money by using the virtual desktop as my computer wouldn't need to be upgraded					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Female)?	17-20	0	1	15	10	16	42
		0.0%	2.4%	35.7%	23.8%	38.1%	100.0%
	21-29	1	3	9	10	13	36
		2.8%	8.3%	25.0%	27.8%	36.1%	100.0%
	30-39	0	0	9	1	8	18
		0.0%	0.0%	50.0%	5.6%	44.4%	100.0%
	40-49	1	0	3	2	2	8
		12.5%	0.0%	37.5%	25.0%	25.0%	100.0%
Total		2	4	36	23	39	104
		1.9%	3.8%	34.6%	22.1%	37.5%	100.0%

Table 51: Benefits of not having to Upgrade Own Computer by Using a Virtual Desktop for Female Students

		I could save money by using the virtual desktop as my computer wouldn't need to be upgraded				Total
		Definitely Not	Neutral	Possible	Definitely	
What is your age group (Staff Female)?	30-39	0	0	2	2	4
		0.0%	0.0%	50.0%	50.0%	100.0%
	40-49	0	1	1	3	5
		0.0%	20.0%	20.0%	60.0%	100.0%
	Over 50	1	4	2	3	10
		10.0%	40.0%	20.0%	30.0%	100.0%
Total		1	5	5	8	19
		5.3%	26.3%	26.3%	42.1%	100.0%

Table 52: Benefits of not having to Upgrade Own Computer by Using a Virtual Desktop for Female Staff

		I could save money by using the virtual desktop as my computer wouldn't need to be upgraded			Total
		Neutral	Possible	Definitely	
What is your age group (Staff Male)?	40-49	0	1	3	4
		0.0%	25.0%	75.0%	100.0%
	Over 50	2	0	0	2
		100.0%	0.0%	0.0%	100.0%
Total		2	1	3	6
		33.3%	16.7%	50.0%	100.0%

Table 53: Benefits of not having to Upgrade Own Computer by Using a Virtual Desktop for Male Staff

		I would like to be able to print from my own technology devices at the UCO				Total
		Definitely Not	Neutral	Possible	Definitely	
What is your age group (Student Male)?	17-20	1	1	4	19	25
		4.0%	4.0%	16.0%	76.0%	100.0%
	21-29	0	2	7	32	41
		0.0%	4.9%	17.1%	78.0%	100.0%
	30-39	0	5	0	5	10
		0.0%	50.0%	0.0%	50.0%	100.0%
	40-49	0	2	0	2	4
		0.0%	50.0%	0.0%	50.0%	100.0%
Total		1	10	11	58	80
		1.2%	12.5%	13.8%	72.5%	100.0%

Table 54: Ability to Print from Own Devices at the UCO via Virtualization for Male Students

		I would like to be able to print from my own technology devices at the UCO					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Female)?	17-20	0	0	3	8	31	42
		0.0%	0.0%	7.1%	19.0%	73.8%	100.0%
	21-29	2	1	4	6	23	36
		5.6%	2.8%	11.1%	16.7%	63.9%	100.0%
	30-39	0	0	5	4	9	18
		0.0%	0.0%	27.8%	22.2%	50.0%	100.0%
	40-49	1	0	5	1	1	8
		12.5%	0.0%	62.5%	12.5%	12.5%	100.0%
Total		3	1	17	19	64	104
		2.9%	1.0%	16.3%	18.3%	61.5%	100.0%

Table 55: Ability to Print from Own Devices at the UCO via Virtualization for Female Students

		I would like to be able to print from my own technology devices at the UCO					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Staff Female)?	30-39	0	1	2	0	1	4
		0.0%	25.0%	50.0%	0.0%	25.0%	100.0%
	40-49	2	0	1	1	1	5
		40.0%	0.0%	20.0%	20.0%	20.0%	100.0%
	Over 50	0	1	4	1	4	10
		0.0%	10.0%	40.0%	10.0%	40.0%	100.0%
Total		2	2	7	2	6	19
		10.5%	10.5%	36.8%	10.5%	31.6%	100.0%

Table 56: Ability to Print from Own Devices at the UCO via Virtualization for Female Staff

		I would like to be able to print from my own technology devices at the UCO			Total
		Unlikely	Neutral	Definitely	
What is your age group (Staff Male)?	40-49	1	0	3	4
		25.0%	0.0%	75.0%	100.0%
	Over 50	0	1	1	2
		0.0%	50.0%	50.0%	100.0%
Total		1	1	4	6
		16.7%	16.7%	66.7%	100.0%

Table 57: Ability to Print from Own Devices at the UCO via Virtualization for Male Staff

		I would not need to worry about the UCO being closed during the holidays as I can still work from home					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Male)?	17-20	0	0	1	8	16	25
		0.0%	0.0%	4.0%	32.0%	64.0%	100.0%
	21-29	0	0	7	8	26	41
		0.0%	0.0%	17.1%	19.5%	63.4%	100.0%
	30-39	1	0	3	2	4	10
		10.0%	0.0%	30.0%	20.0%	40.0%	100.0%
	40-49	0	1	1	1	1	4
		0.0%	25.0%	25.0%	25.0%	25.0%	100.0%
Total		1	1	12	19	47	80
		1.2%	1.2%	15.0%	23.8%	58.8%	100.0%

Table 58: Ability to Work from Home when the UCO is closed (Male Students)

		I would not need to worry about the UCO being closed during the holidays as I can still work from home					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Female)?	17-20	2	0	1	11	28	42
		4.8%	0.0%	2.4%	26.2%	66.7%	100.0%
	21-29	2	0	3	10	21	36
		5.6%	0.0%	8.3%	27.8%	58.3%	100.0%
	30-39	0	1	3	3	11	18
		0.0%	5.6%	16.7%	16.7%	61.1%	100.0%
	40-49	0	0	2	3	3	8
		0.0%	0.0%	25.0%	37.5%	37.5%	100.0%
Total		4	1	9	27	63	104
		3.8%	1.0%	8.7%	26.0%	60.6%	100.0%

Table 59: Ability to Work from Home when the UCO is closed (Female Students)

		I would not need to worry about the UCO being closed during the holidays as I can still work from home					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Staff Female)?	30-39	1	0	1	1	1	4
		25.0%	0.0%	25.0%	25.0%	25.0%	100.0%
	40-49	1	0	2	1	1	5
		20.0%	0.0%	40.0%	20.0%	20.0%	100.0%
	Over 50	0	1	2	3	4	10
		0.0%	10.0%	20.0%	30.0%	40.0%	100.0%
Total		2	1	5	5	6	19
		10.5%	5.3%	26.3%	26.3%	31.6%	100.0%

Table 60: Ability to Work from Home when the UCO is closed (Female Staff)

		I would not need to worry about the UCO being closed during the holidays as I can still work from home		Total
		Possible	Definitely	
What is your age group (Staff Male)?	40-49	0	4	4
		0.0%	100.0%	100.0%
	Over 50	1	1	2
		50.0%	50.0%	100.0%
Total		1	5	6
		16.7%	83.3%	100.0%

Table 61: Ability to Work from Home when the UCO is closed (Male Staff)

		It would help me greatly being able to access the UCO programs from abroad					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Male)?	17-20	3	0	7	4	11	25
		12.0%	0.0%	28.0%	16.0%	44.0%	100.0%
	21-29	5	4	7	13	12	41
		12.2%	9.8%	17.1%	31.7%	29.3%	100.0%
	30-39	2	0	3	2	3	10
		20.0%	0.0%	30.0%	20.0%	30.0%	100.0%
	40-49	0	0	2	1	1	4
		0.0%	0.0%	50.0%	25.0%	25.0%	100.0%
Total		10	4	19	20	27	80
		12.5%	5.0%	23.8%	25.0%	33.8%	100.0%

Table 62: Ability for Male Students to Access UCO Programs from Abroad

		It would help me greatly being able to access the UCO programs from abroad					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Female)?	17-20	3	4	6	11	18	42
		7.1%	9.5%	14.3%	26.2%	42.9%	100.0%
	21-29	6	2	9	8	11	36
		16.7%	5.6%	25.0%	22.2%	30.6%	100.0%
	30-39	2	1	6	3	6	18
		11.1%	5.6%	33.3%	16.7%	33.3%	100.0%
	40-49	4	1	2	0	1	8
		50.0%	12.5%	25.0%	0.0%	12.5%	100.0%
Total		15	8	23	22	36	104
		14.4%	7.7%	22.1%	21.2%	34.6%	100.0%

Table 63: Ability for Female Students to Access UCO Programs from Abroad

		It would help me greatly being able to access the UCO programs from abroad					Total
		Definitely Not	Unlikely	Neutral	Possible	Definitely	
What is your age group (Staff Female)?	30-39	1	0	1	2	0	4
		25.0%	0.0%	25.0%	50.0%	0.0%	100.0%
	40-49	3	2	0	0	0	5
		60.0%	40.0%	0.0%	0.0%	0.0%	100.0%
	Over 50	2	2	3	0	3	10
		20.0%	20.0%	30.0%	0.0%	30.0%	100.0%
Total		6	4	4	2	3	19
		31.6%	21.1%	21.1%	10.5%	15.8%	100.0%

Table 64: Ability for Female Staff to Access UCO Programs from Abroad

		It would help me greatly being able to access the UCO programs from abroad			Total
		Definitely Not	Neutral	Definitely	
What is your age group (Staff Male)?	40-49	1	0	3	4
		25.0%	0.0%	75.0%	100.0%
	Over 50	0	1	1	2
		0.0%	50.0%	50.0%	100.0%
Total		1	1	4	6
		16.7%	16.7%	66.7%	100.0%

Table 65: Ability for Male Staff to Access UCO Programs from Abroad

		I would be very happy to use the UCO virtual desktop				Total
		Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Male)?	17-20	1	0	4	20	25
		4.0%	0.0%	16.0%	80.0%	100.0%
	21-29	0	5	13	23	41
		0.0%	12.2%	31.7%	56.1%	100.0%
	30-39	0	2	3	5	10
		0.0%	20.0%	30.0%	50.0%	100.0%
	40-49	0	1	1	2	4
		0.0%	25.0%	25.0%	50.0%	100.0%
Total		1	8	21	50	80
		1.2%	10.0%	26.2%	62.5%	100.0%

Table 66: Acceptability of a Virtual Desktop (Male Students)

		I would be very happy to use the UCO virtual desktop				Total
		Unlikely	Neutral	Possible	Definitely	
What is your age group (Student Female)?	17-20	1	2	12	27	42
		2.4%	4.8%	28.6%	64.3%	100.0%
	21-29	0	4	10	22	36
		0.0%	11.1%	27.8%	61.1%	100.0%
	30-39	1	1	6	10	18
		5.6%	5.6%	33.3%	55.6%	100.0%
	40-49	0	1	4	3	8
		0.0%	12.5%	50.0%	37.5%	100.0%
Total		2	8	32	62	104
		1.9%	7.7%	30.8%	59.6%	100.0%

Table 67: Acceptability of a Virtual Desktop (Female Students)

		I would be very happy to use the UCO virtual desktop		Total
		Neutral	Definitely	
What is your age group (Staff Male)?	40-49	0	4	4
		0.0%	100.0%	100.0%
	Over 50	1	1	2
		50.0%	50.0%	100.0%
Total		1	5	6
		16.7%	83.3%	100.0%

Table 68: Acceptability of a Virtual Desktop (Male Staff)

		I would be very happy to use the UCO virtual desktop			Total
		Neutral	Possible	Definitely	
What is your age group (Staff Female)?	30-39	0	1	3	4
		0.0%	25.0%	75.0%	100.0%
	40-49	0	2	3	5
		0.0%	40.0%	60.0%	100.0%
	Over 50	4	2	4	10
		40.0%	20.0%	40.0%	100.0%
Total		4	5	10	19
		21.1%	26.3%	52.6%	100.0%

Table 69: Acceptability of a Virtual Desktop (Female Staff)

Appendix 9: Licence costs

Product Name	Retail Cost	Student Discount
Windows XP	**£25**	**£25**
Windows 7	**£189.99**	**£189.99**
Windows 8	**£189.99**	**£49.99**
Office Pro	**£389.99**	**£389.99**
Access 2010		
Excel 2010		
One Note 2010		
Power Point 2010		
Publisher 2010		
Project 2010	**£570.00**	**£570.00**
Word 2010		
SPSS 20	**£71.56**	**£71.56**
Sketchup 8 Pro	**$495 = £321.45**	**$49 = £31.82**
AutoCAD Design Suite Ultimate 2013	**£6785**	**£156**
3Ds MAX	**£3680**	**£156**
Adobe Master Suite	**£2,398.80**	**£758.99**
Adobe Flash	**£623.50**	**£623.50**
Adobe Photoshop	**£631.20**	**£207.50**
Adobe Dreamweaver	**£339.99**	**£138.84**
Adobe Illustrator	**£546.64**	**£295.78**
Adobe After Effects	**£928.49**	**£928.49**
End Note	**£180**	**£93.60**
TOTAL:	**£17,872**	**£4,687**

Full Price *(cheapest prices as of 15 April 2013):*

Amazon (2013) *Adobe Creative Suite 6 Master Collection (PC)* [online] Available at: http://www.amazon.co.uk/Adobe-Creative-Suite-Master-Collection/dp/B007UXCQFC/ref=sr_1_1?s=software&ie=UTF8&qid=1367487715&sr=1-1&keywords=Adobe+master+CS6 [Accessed 15 April 2013].

Amazon (2013) *Adobe After Effects CS6 (PC)* [online] Available at: http://www.amazon.co.uk/Adobe-After-Effects-CS6-PC/dp/B007UXCB16/ref=sr_1_1?s=software&ie=UTF8&qid=1367486684&sr=1-1&keywords=After+Effects+CS6 [Accessed 15 April 2013].

Amazon (2013) *Adobe Photoshop CS6 (PC)* [online] Available at: http://www.amazon.co.uk/s/ref=nb_sb_noss_1?url=search-alias%3Dsoftware&field-keywords=photoshop+CS6&rh=n%3A300435%2Ck%3Aphotoshop+CS6 [Accessed 15 April 2013].

Amazon (2013) *Adobe Flash Pro CS6 (PC)* [online] Available at: http://www.amazon.co.uk/Adobe-Flash-Pro-CS6-PC/dp/B007UXD2J6/ref=sr_1_1?s=software&ie=UTF8&qid=1367487134&sr=1-1&keywords=Flash+CS6 [Accessed 15 April 2013].

Amazon (2013) *Adobe Dreamweaver CS6 (PC)* [online] Available at: http://www.amazon.co.uk/Adobe-Systems-Inc-65168512-Dreamweaver/dp/B007UXCZR6/ref=sr_1_1?s=software&ie=UTF8&qid=1367487244&sr=1-1&keywords=Dreamweaver+CS6 [Accessed 15 April 2013].

Amazon (2013) *Adobe Illustrator CS6 (PC)* [online] Available at: http://www.amazon.co.uk/Adobe-Systems-Inc-65165611-Illustrator/dp/B007UXD3YU/ref=sr_1_1?s=software&ie=UTF8&qid=1367487848&sr=1-1&keywords=illustrator+CS6 [Accessed 15 April 2013].

Microsoft Store (2013) *Office Professional 2013* [online] Available at: http://www.microsoftstore.com/store/msuk/en_GB/pdp/productID.260260300 [Accessed 15 April 2013].

Amazon (2013) *Microsoft Project Professional 2010 (PC)* [online] Available at: http://www.amazon.co.uk/Microsoft-Project-Professional-2010-PC/dp/B003FP0G24/ref=sr_1_3?s=software&ie=UTF8&qid=1367494837&sr=1-3&keywords=project+2010 [Accessed 15 April 2013].

Autodesk Store (2013) *AutoCAD Design Suite Ultimate 2013* [online] Available at: http://store.autodesk.co.uk/DRHM/store [Accessed 15 April 2013].

Autodesk Store (2013) *Autodesk 3ds Max 2014* [online] Available at: http://store.autodesk.co.uk/store/adsk/en_GB/buy/productID.269713600 [Accessed 15 April 2013].

Microsoft Store (2013) *Windows 8 Pro* [online] Available at: http://www.microsoftstore.com/store/msuk/en_GB/pdp/productID.272001400 [Accessed 15 April 2013].

Amazon (2013) *Microsoft Windows 7 Professional, Full Version (PC DVD), 1 User* [online] Available at: http://www.amazon.co.uk/Microsoft-Windows-Professional-Full-Version/dp/B002DUCMTC/ref=sr_1_1?s=software&ie=UTF8&qid=1367492255&sr=1-1&keywords=windows+7+pro [Accessed 15 April 2013].

Amazon (2013) *Microsoft Windows XP Professional with Service Pack 3 OEM* [online] Available at: http://www.amazon.co.uk/Microsoft-Windows-Professional-Service-OEM/dp/B000JTDV6M/ref=sr_1_2?s=software&ie=UTF8&qid=1367492432&sr=1-2&keywords=windows+xp [Accessed 15 April 2013].

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dd11-bb6c-0030485a6b08&vsro=8&srch=+SPSS%C2%AE+Statistics&utm_source=LandingPage-SPSS-Statistics-21&utm_medium=LandingPage&utm_campaign=SPSS&JSEnabled=1 [Accessed 15 April 2013].
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Bilaney Consultants (2013) *EndNote Single User Licence Pricing* [online] Available at: http://www.bilaney-consultants.co.uk/prices/endnote/ [Accessed 15 April 2013].

XE (2013) *XE CURRENCY CONVERTER* [online] Available at: http://www.xe.com/currencyconverter/convert/?Amount=49&From=USD&To=GBP [Accessed 15 April 2013].

Student Discount *(cheapest prices as of 15 April 2013):*

Amazon (2013) *Master Collection CS6 Student + Teacher (Online Validation) Win (student and teacher eligibility requirements apply for this product)* [online] Available at: http://www.amazon.co.uk/Master-Collection-Student-Teacher-Validation/dp/B007UXDA3E/ref=sr_1_3?s=software&ie=UTF8&qid=1367487777&sr=1-3&keywords=Adobe+master+CS6 [Accessed 15 April 2013].

Amazon (2013) *Adobe After Effects CS6 (PC)* [online] Available at: http://www.amazon.co.uk/Adobe-After-Effects-CS6-PC/dp/B007UXCB16/ref=sr_1_1?s=software&ie=UTF8&qid=1367486684&sr=1-1&keywords=After+Effects+CS6 [Accessed 15 April 2013].

Amazon (2013) *Adobe Photoshop Extended CS6, Student and Teacher Version (Mac) (student and teacher eligibility requirements apply for this product)* [online] Available at: http://www.amazon.co.uk/Adobe-Photoshop-Extended-Student-Teacher/dp/B007UXDBV0/ref=sr_1_4?s=software&ie=UTF8&qid=1367487418&sr=1-4&keywords=Photoshop+CS6 [Accessed 15 April 2013].

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Amazon (2013) *Adobe Dreamweaver CS6, Student and Teacher Version (PC) (student and teacher eligibility requirements apply for this product)* [online] Available at: http://www.amazon.co.uk/Adobe-Dreamweaver-Student-Teacher-Version/dp/B007UXDB3I/ref=sr_1_2?s=software&ie=UTF8&qid=1367487495&sr=1-2&keywords=dreamweaver+CS6 [Accessed 15 April 2013].

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